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BRIEFLY TOLD.

DECEMBER MEETING, NEW YORK SECTION, ILLUMINATING ENGINEERING SOCIETY.—"Architects' Night" would seem quite descriptive of the December meeting of the New York Section of the Illuminating Engineering Society, which was held the evening of the 8th, in the United Engineering Societies Building. The Chairman (Dr. A. H. Elliott) first called upon Secretary Marshall to abstract the paper by Prof. Edward L. Nichols, the theme of which was "Some Notes on the Early History of Standards of Lights." The abstracting instructions were given to the Secretary owing to the unavoidable absence of the author. In effect, the Secretary merely read the paper by title, which was the leading reason why the paper was not discussed. The other literary contribution of the evening was a well set story or description of the "Lighting of the Allegheny County (Pa.) Soldiers' Memorial Building." It was from the pen of Mr. Bassett Jones, Jr., who certainly gave an excellent recounting of the structure, more especially, of course, in relation to the lighting thereof. The story developed that the main feature of the illumination was in the color of the light sources eked out and amplified by the decorations. The discussion was opened by Mr. Hornbostel, of the architectural firm who designed the structure. He averred that the improvements in the instance of light sources had made it possible for the designer to seek and obtain effects at once useful and beautiful, whereas at an earlier period, light sufficient to enable us to see was about all that could be expected. More especially was this true in examples where color effects were desirable and desired. It was matter for congratulation that well over ½ dozen sources (differing widely too) were now available. Mr. Jones called attention to the fact that the flaming arc lamps which were operated on a 60-cycle, alternating current, distinctly gave out the musical note, low D, which discovery had been made during the course of concerts conducted by the Philharmonic Society Orchestra. Others who interestingly contributed to the discussion were Messrs. Jacoby, Comstock, Stickney and Taylor.

THE TORONTO JUNIOR GAS ASSOCIATION.—We are indebted to Mr. Harry D. Keillor, Secretary and Treasurer of the Toronto Junior Gas Association, for the following mention respecting its formation: The opening meeting of the Toronto Junior Gas Association took place on Thursday, December 1st, at the Association Room, 38 Toronto street, Toronto. The Hon. President, Mr. Arthur Hewitt, addressed the meeting, offering words of counsel and proffering the assistance of the gas interest in general to sustain the Association in its purposes and aims. President Armstrong and others also delivered addresses in sympathy with that of the Honorary President. The attendance was large and enthusiastic, and every indication points to the growth of the Junior body in numbers and value. Its officers are:

Hon. President—Mr. Arthur Hewitt.
President—Mr. J. J. Armstrong.
Vice-President—Mr. Edward T. Rae.
Hon. Secretary and Treasurer—Mr. Harry D. Keillor.

During the meeting an excellently prepared Syllabus with Membership Card was distributed amongst the members, and from it we glean that from the 1st inst. to April 28th (this will be the date of the General Annual Meeting) 14 lectures on as many different subjects of general interest to gas men will be delivered. For instance, the third of these was to have been delivered last Friday, on which occasion a prior visit to Station B, Toronto gas works (the 10th inst.) will be discussed. On the 22d inst. the Association will listen to a lecture on "Some Properties of Gases," the lecturer being Mr. L. Jacques, of Toronto. The qualifications for membership in the body are:

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"Any person actively engaged in the manufacture or distribution of gas, or in the recovery and working up of residual products from these and kindred works, or at present being trained as an engineer or chemist, with the intention of being engaged in any of these industries. Honorary members to be elected at the discretion of the Council, from persons associated with gas manufacture, but not engaged in the manufacture of gas appliances, shall be eligible to take part in the reading of papers, discussions, etc., but shall not hold office or take part in the voting."

CURRENT MENTION—

MR. A. H. STRECKER returned recently from a somewhat protracted trip through Europe, greatly benefited by his journey. A sequence of his return, however, is not so pleasant that it will be hailed with acclaim, even though his act insures him immunity from the vexation and worry of daily routine. He has resigned the important position of Engineer-in-Chief of the Essex Division of the Public Service Gas Company, of New Jersey. It is some satisfaction, however, to know that he proposes to retain a more or less active connection with that Corporation, through his having consented to remain on the staff as Consulting Engineer, especially in respect of construction. Mr. Strecker has been actively connected in an engineering capacity with the gas supply of Newark for 30 years or more, and in that time he has watched the growth of the gas business in Essex county with close attention, and much of its present magnitude is due to his untiring energy and his well-trained engineering skill. As co-worker in that field with the late Mr. Eugene Vanderpool (whose memory to many is yet inspiring and upholding) he was; and 'tis surely the wish of all who know him, that this partial retirement from the active ranks will be crowned with good health and happiness, which spring from a knowledge that in his busy days - and these were many and long—his work was well done.

MR. FREDERIC EGNER has removed permanently from Norfolk, Va., and has established himself in pleasant quarters in the premises, No. 516 Quincy street, Washintgon, D. C. Of course, the veteran extends to all his friends happening Washington way a fraternal invitation to look in upon him.

A CORRESPONDENT in Grand Forks, N. D., writing to us under date of the 12th inst., informs us of the following happenings: "Dear JOURNAL.—The officials of the Red River Power Company, of Grand Forks, paid a well-deserved tribute to the oldest employee in line of service when they tendered to Mr. Thomas Roycraft, a dinner at 'The Frederick' last night, at which function was made public the announcement that the retirement of the guest of honor from the service of the Company was a fact. Enough will have been said about the material side of the occasion when it is remarked that the dinner in all its details was as if nothing to make it a perfect success had been omitted. When the cigars were lighted Manager Brown, in the capacity of Toastmaster, in a speech that surely had close connection with heart and head, narrated their respect, regard and friendship for their guest, whose long life amongst them, both in business and social contact, had endeared him to them. At the conclusion of his speech Mr. Brown handed to Mr. Roycraft a valuable silver-mounted travelling outfit, one or two of the pieces of which (as a participant remarked) might be considered not necessities, remembering that Mr. Roycraft's thatch is not as bushy as it was when he first located in Grand Forks. Mr. Roycraft's response was quite like his methods. Quickly and connectedly he expressed his thanks for all the kindnesses which had been shown him in his long period of work amongst them, and assured them that his stay amongst them had been of the kind that left no trace of the wish that it might have been otherwise. Other speeches were made that echoed the sentiments of Manager Brown, the one by Engineer Nissley being especially vigorous and fraternal."

AND thus retires to a life (and lengthy may it be) of ease and quietude a man whose induction to the gas business dates from 1878, in which year he was on the staff of Edmundson & Co., Dublin, Ireland. About 2 years later he came to the States, and in time became connected with the plant at Fargo, N. D. In 1887 he assumed charge of the plant of the Grand Forks (N. D.) Company as Superintendent. That position he held continuously, until June 1st, 1910, when the Grand Forks Company, which had in the meanwhile engaged in the supply of electric currents for light, heat and power—and if we mistake not in the supply of steam heating currents as well—was taken over for operation by the Byllesby syndicate, of Chicago. Mr. Roycraft proposes to take things easily for a while, then likely he will make a voyage to the land of his birth.

A CORRESPONDENT in Albany, N. Y., writing under date of the 12th inst., has this to say: As one interested in one of the dozen gas companies of, may I write, the junior class, that were haled last week before the up-State section of the New York Public Service Commission, I would like to make some comment on the proceedings thereat. We were 12 in number, and we not only looked like culprit freshmen, but our treatment in the main was of the order accorded to collegians of higher or lower class, when they are on the carpet for having run counter to the rules of their temple of learning. Perhaps this may be made clearer if I give you an extract or two from the speech of Chairman Stevens, when formally opening the "investigation." He said: "The Commission endeavors, on the failure of a corporation, in the first instance, to observe the terms of the law, to induce it to perform its duty to the public by mild and gentle means within its power. Gas manufactured by the companies which have been summoned here to-day has been inspected; reports of these tests have been sent to you; you have been written to and more or less remonstrated with; but all the measures that the Commission has resorted to have proved non-efficacious. The view of the Commission is that people are buying illuminating power, although it is measured by the cubic foot of gas, and that when you are supplying gas you are under contract to supply illuminating power; and when you fail to supply what you are under contract to furnish you are in the same position as the grocer who sells 9 eggs to a dozen or 3 pecks for a bushel. The object of this proceeding is to find out why you cannot deliver the dozen or the bushel." I said college students; but I should have said primary pupils in the "Public." It is all very nice for the Commissioner to urge that it is the duty of a company to sell gas to its customers of the nature prescribed by law; but the superintendent of a small works, from the very nature of the district and the residents that are being so supplied, is utterly unable to do that which can be readily done by his brother superintendent in a larger district, the residents of which are free users of gas. Take for instance the companies under fire by the Commission in this hearing. I know of two the Superintendents of which would scarce dare order a Jones jet photometer on their own responsibility! And on the books of those same companies, I will warrant, may be found the names of 20 consumers (out of a total, say of 100) whose average gas bill will not exceed 50 cents per month. The 9 eggs problem is an easy one for the grocer, simply because "eggs are eggs," until they are broke, at any rate. It is not possible to hold the "managers" of very small companies to a 100 per cent. accountability in their dealings with the public, and it is hoped that the Commission will arrive speedily at an understanding thereof, so that the owners of very small companies may not be unduly harassed. I do not wish to be taken as saying that only very small companies were included, for in the dozen were the Newburgh, Watertown, Oswego, and Central New York Power concerns.

Recent Patent Issues.

Prepared for the AMERICAN GAS LIGHT JOURNAL by ROYAL E. BURNHAM, solicitor of patents and counselor in patent causes, 833 Bond Building, Washington, D. C., from whom illustrations and specifications of any patent mentioned below may be obtained for 10 cents.

976,933. Apparatus for Cleaning Gas Pipes. F. W. C. Schniewind, New York City.
977,108. Inverted Incandescent Gas Lamp. P. Lucas, Sudende, near Berlin, Germany.
977,119. Apparatus for Handling Coke, etc. W. C. Mitchell, Sydney, Nova Scotia, Canada.
976,987. Gas Fitting. W. Corbridge, Bury, England.
977,469. Peat Gas Producing Process. J. D. Oligny, Montreal, Quebec, Canada, assignor to Peat Gas and Coal Company, same place.
977,521. Electrically Ignited Burner. E. J. Goldblatt, Chicago, Ills.
977,522. Coke Drawing Machine. H. Greer, Jr., Chicago, Ills.
977,651. Gas Producer. W. B. Hughes, Cleveland, O.
977,820. Gas Pressure Regulator. L. A. Merk, Wilkinsburg, Pa., assignor of one-half to E. Ruud, Pittsburgh, Pa.
977,858. Automatic Cut Off. J. C. Dupee, Chicago, Ills., assignor of one-half to the Padden Gas and Electric Co., New Hampton, Ia.
977,874. Manufacture of Gas. W. B. Hughes, Cleveland, O.
977,904. Gas Burner. H. Ruppert, Zurich, Switzerland.
977,907. Gas Purifying Apparatus. E. Temple, Sydney, New South Wales, Australia.
977,909. Process of Removing Tar in Recovering Ammonia. E. Wagener, Dahlhausen-on-the Ruhr, Germany.
977,970. Means for Indicating and Recording the Calorific Value of Gases. F. Sawford, Sydney, Nova Scotia, Canada.
978,123. Burner for Water Heaters. C. Hart, Oakland, Cal., assignor to the Hart Heater Company.
978,127. Gas Stove. J. M. Brock, New York City, assignor to W. M. Crane Company.

Outdoor Lighting in England.—No. VII.

[By Norton H. Humphrys.]

A most important problem in connection with outdoor lighting is the means to be adopted for turning on or shutting off the lights at the hours required. Like many others, it is one of modern growth, because up to a very recent time the plug tap and the human hand represented the only practicable method available. Determined attempts have been made to effect the desired result by mechanical methods. As will presently be seen, the first dates back 50 years, and it is more than 30 years ago that I was told of a village in Somersetshire where a mechanical device was in successful operation. These isolated and spasmodic efforts have, after many years, crystallized into a practicable form. Continued determined effort to deal with a very complicated subject has at last been attended with a measure of success, and a very large number of mechanical lighters are to-day in actual use and giving satisfaction.

It may here be remarked that the act of turning on the gas is separate and distinct from the ignition of the same, and that something will be said about "igniters" in a separate section.

The cost of lighting and extinguishing by hand will vary according to the rate of wages paid in the district, the distance between the lamps, and whether or not the man has to ignite the gas in addition to turning it on. By-pass burners are now largely used both for outdoor and indoor lighting, and when these are adopted a man can light a larger number of lamps in an hour than when he has to carry and use a torch. In important or busy thoroughfares the number of lamps per mile is greater than in a by-lane, a suburb or a village, and in the center of the town there is very little back journeying, whereas in the suburbs there may be long outlying stretches of road that involve a return journey. The usual rule is to give each lamplighter a run of as much ground as he can cover in an hour, say about 5 miles on level ground, or less if undulating, and to carefully arrange the run with a view to minimize back journeying. For instance, if there is a long stretch of road extending a mile or more, that involves a back journey, it can be arranged to come on the beginning of a run, so that the lighter can start at one end at the proper time. Instead of having to travel up the road and back again within the hour of operations, one-half of the journey is done before time. If the arrangement of the roads does not lead itself to what is known as a "round," it is a good plan to start at the outskirts and work towards the center, care being taken that the most important thoroughfares come early in the run and are not left till the last. The number of lamps in a run may be anything between 120 and 40, and will average out 80 to 90 per man over half a dozen to a dozen men. The number of lamps on a run will have a great effect on the cost of lighting and extinguishing per lamp, which must not be overlooked when tendering for the public lighting of isolated small districts. The continued variation with irregularity of the hours for lighting and extinguishing throughout the year adds greatly to the expense, because a man naturally expects more money for working late at night or early in the morning than the current rate during the usual hours of labor.

In small districts of 200 lamps or less the lamp lighter is a man having other work, but with this exception it is usual for a man to undertake the lighting, extinguishing and cleaning over a "run" as an exclusive occupation, probably also including the painting and repairing of the lanterns and painting the columns.

The reasons for seeking to supercede human by mechanical labor are economy in wages and in consumption of gas. The cost for lighting and extinguishing only (cleaning and painting will be the same in any case) averages 8s. or 9s. per lamp per annum, and as all the lamps must be lighted before or extinguished after certain specified hours, it follows that there is a loss or waste averaging half an hour per lamp each way. The actual average hours of burning will be half an hour before and half an hour after the schedule time, which means 365 hours in a year added to the nominal period of 3,700 to 3,800 hours, or nearly 10 per cent. on the consumption of gas. Where incandescent mantles are used, even the most careful men cannot avoid an occasional unlucky jerk in the act of turning on or off, and in any case the life or well being of the mantle is more prejudiced than when the lighting and extinguishing can be done without shock. Against this it must be remembered that mechanical arrangements cannot be provided and maintained in order except at considerable cost, and that at the best the machine is not more reliable than the man. The human agent can also exercise some judgment in the matter of variation from the schedule time, on a dark winter afternoon, or the long twilight of summer, or in case of sudden fog, to which all our large cities and especially those in the manufacturing districts are liable.

The introduction of the incandescent mantle also involves an additional operation that may be described as maintenance. This, like the cleaning and painting, must necessarily be accomplished by human agency, and a proper maintenance scheme is a necessary feature of lighting by the incandescent mantle. There are sure to be a few broken mantles or other defects that, for the credit of the company and the system, must be properly remedied. Each man must report all defects immediately at the conclusion of his round. Sometimes each lighter also undertakes the maintenance on his round, and this plan has the advantage of affording additional inducement for care in regard to the mantles, but on the whole it is better to leave the maintenance to the proper department. At this time of day no gas works should be run without a maintenance department for all classes of lighting, and if there are still any so much behind the times the defect should be remedied without delay. The maintenance can be taken on by the department as a part of their other work. After the lighter has finished and reported himself he is usually in need of rest and a meal, and it is hard if he has to go out again, perhaps to the far end of his district, to replace a mantle, and obviously he cannot stop on his round to renew mantles.

I will now outline a plan that has proved efficient and satisfactory over several years in practice. One of the lamplighters is appointed foreman and is generally held responsible for setting out the work of the others. In consideration of his extra duties he has a shorter round than the average, so as to enable him to be at his desk at a centrally situated office before the others return. He is provided with daily report forms, time sheets and a book with ruled columns, showing the date that each street was visited for cleaning, also details of painting and repair. He is expected to keep lists of the lamps on each round. As each man reports himself on the conclusion of his round, the exact time is entered and also a list of defects. Two maintenance men are in attendance, and while the writing up of the report is in progress they are getting a supply of mantles and glass,, so as to be ready to start off immediately on its completion. All the defects having been made good, the report is filed at the office. The maintenance men are instructed to take the important corners or thoroughfares first and to finish in the outskirts, and by this means the greater and more prominent part of the defects can be made good within an hour. The public lamp men work in pairs, as it has not been found safe to send one man about after dark without a second, carrying a danger lantern, to guard the foot of the ladder while the mantle is being put on. Also there is rather more to carry than one man is capable of. The outfit includes a ladder, a lantern and lighting torch, a box for mantles and chimneys and a bag with two compartments, one for broken mantle ash (this will sell from 8s. to 10s. per pound) and the other for mantle boxes, broken glass, etc. It does not look well to see a litter of mantle boxes or broken glass at the base of each lamp, and the men are expected to see that nothing of the sort is dropped in the streets. On the main roads the second man has to look out for reckless traffic, and, if the ladder abuts on the road, for motorists and cyclists. One pair of men can attend to the defects on 700 or 800 lamps in ordinary weather, but if the wind is unusually high a second pair will be required. In that case the first pair take a copy of the first reports brought in, and as soon as they have made up a round they get off to work, leaving a second pair to take the remainder.

By some such plan as this the success of incandescent gas light is assured. But if a few lamps are left unlighted for the whole evening, they are sure to attract notice and comment, especially if there is competition, and in any case they are a bad advertisement. It is quite as important, perhaps more so, to stop bad advertisements as to issue good ones.

If mechanical lighting is entirely depended upon there should be systematic inspection. The number of defects will not be so great, and a man on a bycicle, in the course of an hour's run, can inspect an area equivalent to four or five ordinary "runs," as it is not necessary to traverse every street. The inspector reports defects at the central office as above.

There are two orders of mechanical lighting, the independent and the controllable, and the latter to some extent carries the advantage of being able to vary the schedule time on emergency. The independent class are actuated at pre-arranged times by clockwork, each one being self-contained, and not capable of control from a center. The clock must be an accurate time keeper, and it is wound and set

once a week. One difficulty is that however carefully made and fitted the tap works easier at one time than at another, and a variable load on the spring will affect the accuracy of the time keeping. The same thing may be observed with a cheap chronograph watch having only one spring. If the stop is used irregularly the watch does not keep good time. Various attempts have been made to overcome this, such as the use of a second spring to do the work of moving the cap, similar to the arrangements of a striking clock, or a combination of the independent and the controllable, the presence of the gas being made to liberate the spring which does the work of turning the tap.

The controllable action consists of the utilization of the gas in the main pipes as a means of conveying a wave sufficient to actuate the mechanism at each burner. The same result could be more effectually produced by a separate main for the public lamps, but while this might be practicable over a comparatively small area, such as a public park or place of outdoor amusement, it is obviously out of the question under ordinary circumstances. The same may be said of devices actuated by electricity and involving a special circuit extending from lamp to lamp. The applications of a pressure actuated system, while free from the cast iron inelasticity peculiar to clockwork, must necessarily be somewhat limited by local conditions of altitude and of consumption. It is very rarely possible to maintain an even pressure all over, and in every part of a large district, under ordinary conditions of consumption, with large gas engines, cookers, gas fires, etc., being continually turned on or shut off. The variation due to altitude is constant, and the apparatus might be adjusted to suit it at each lamp. But the actual pressure at any part of a district, will be the governor or initial pressure, less a variable loss representing the force required to drive the gas from the initial point to the point of supply. If the consumption is small at the moment, the loss may be a negligible quantity. But it cannot be so when the consumption is large.

In practice an endeavor is made to meet this loss in transmission by varying the supply pressure at the works governor, at times when an increased demand is expected. It is always the rule to increase the governor pressure at dusk, to reduce it at midnight, and to regulate it at various hours during the day. But the increased use of gas for purposes other than lighting during the day for purposes that cannot be forecast like the evening lighting or the mid-day meal, tends to level down the variations of pressure during the 24 hours, and things are trending towards full pressure from 6 A.M. to 12 midnight, coupled with the use of regulators at each meter. These modern conditions greatly increase the difficulties of applying the controllable class of apparatus. It requires a sudden excess or wave of about $\frac{5}{10}$ to operate it, which could easily be arranged by mechanical means, if the full holder pressure is already required, but one would like to know the limit of distance to which the wave would extend under the usual variable conditions of consumption.

There is also the financial aspect to be considered. Under normal circumstances the cost of the appliances must fall on the gas company, and the question is whether they have a chance of recouping it. If they have a 7 or 10 years' contract the proposition is feasible, but the initial outlay would be equivalent to 6 months' total receipts, and therefore if the contract is subject to 6 months' notice it is out of the question, as the appliances are valueless if the contract passed into other hands. The cheapest arrangement on the market at present would involve a cost of 30s. per lamp, or £1,500 for a district of 1,000 lamps. Recognizing the force of this objection, the principal makers are supplying apparatus on hire by the year, the usual rate being 4s. to 5s. This proposal has found much favor because it involves no risk of loss, as the saving affected by the use of the apparatus pays for the hire. There must necessarily be some annual outlay for keeping in repair, because a delicate clockwork or mechanical device must be cleaned and overhauled once a year at least. It is exposed to dust, damp, variation of temperature, etc. The makers undertake the responsibility of keeping the appliance in order, without additional charge. On these conditions there are few who would not find it worth while to encourage investors by, at the least, a trial on a small scale. It cannot be denied that a reliable system for the control of the public lamps would be a most important advantage to sellers of gas.

[OFFICIAL REPORT—AS APPOVED BY COMMITTEE ON PUBLICATION.—CONTINUED FROM PAGE 1135.]

THE FIFTH ANNUAL MEETING, AMERICAN GAS INSTITUTE.

HELD IN NEW YORK CITY, OCTOBER 19TH TO 21ST (INCLUSIVE), 1910.

FIRST DAY, WEDNESDAY, OCTOBER 19TH.—AFTERNOON SESSION.

DETERMINATION OF THE CALORIFIC VALUE AND OF OPERATING CONDITIONS FROM ANALYSIS OF INDUSTRIAL GASES—*Continued.*

FORMULA FOR H_2.

$$\text{Per cent. by vol of } H_2 = \frac{2 \times (\text{1st contraction}) - 4 \times (\text{2d contraction})}{3}$$

× constant. Per cent. by vol. of CH_4 = 2d contraction × constant. The foregoing formula is volumetric, not gravimetric, and is based on Avuagadro's law, which states: "Under the same conditions of temperature and of pressure equal volumes of all gases contain the same number of molecules." Since the analyses are made under the same conditions of temperature and of pressure this law applies. A clearer understanding of the derivation of the formula can probably be had by a graphic representation, and Fig. 6 is referred to.

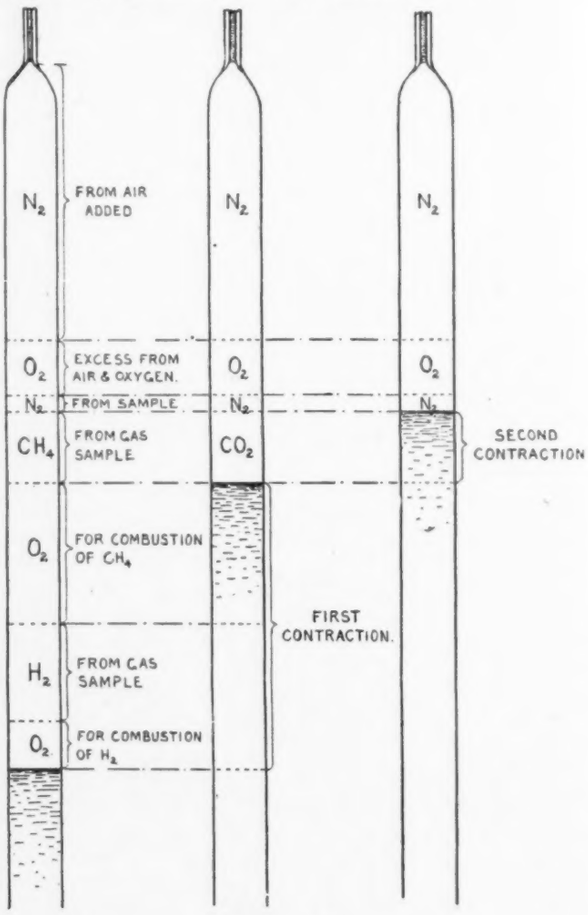

FIG. 6.

Consider A, B and C to be the burette, A being before the explosion, B being after the explosion, and C after the second contraction. According to the formulæ:

$$H_2 + \tfrac{1}{2}O_2 = H_2O,$$

and

$$CH_4 + 2O_2 = CO_2 + 2H_2O.$$

Two volumes of H_2 will combine with 1 volume of O_2 and leave no residue which will occupy space in the burette. That is to say, that for every 2 volumes of hydrogen consumed 3 volumes disappear, of which 2 volumes were hydrogen and 1 was oxygen. Or, in other words, $\frac{1}{3}$ of a contraction, due to an explosion of the hydrogen, was hydrogen.

Now, a given volume of methane when burned produces its own volume of CO_2, but at the same time causes the disappearance of 2 volumes of O. That is, there will be as much CO_2 after the explosion of the methane as there was of methane before the explosion, but twice this volume of oxygen willhave disappeared. Or there will be a disappearance, as contraction due to combination of the oxygen with the hydrogen of the methane equal to twice the volume of the original methane. Thus after the explosion the only thing left in the burette to represent the original hydrogen and methane is a certain volume of carbon dioxide, equal to the orginal volume of methane, all of the hydrogen along with $2\frac{1}{2}$ volumes of the excess oxygen having disappeared.

If there was no methane at all present the percentage of hydrogen in the original mixture would be equal to $\frac{4}{3}$ of the contraction due to the explosion of the hydrogen, but at the same time there is a contraction due to the combination of the hydrogen with the oxygen. There is also a contraction due to the combination of the methane with oxygen, and hence the first contraction is a gross contraction

due to the combination of both the hydrogen and the methane. The next step is to determine what proportion of this gross contraction is due to the hydrogen and what to the methane.

We have seen that for every volume of carbon dioxide present before the absorption with KOH that 2 volumes of oxygen have disappeared. The "second contraction" gives us this volume of carbon dioxide, so that by multiplying it by 2 we get the total contraction due to the methane, and subtracting this from the gross contraction due to the hydrogen and the methane, we get the net contraction due to the hydrogen alone, $\frac{2}{3}$ of which would be the volumetric percentage of the hydrogen in the portion taken, and this multiplied by the "constant" gives the percentage in the original gas. The volume of carbon dioxide as given by the second contraction is equal to the volume of methane in the portion of the sample exploded, which, multiplied by the "constant," gives the percentage in the original gas. The constituent which we call "methane"—CH_4—often contains in addition ethane (C_2H_6) especially in rich gases and in natural gas from wells which are approaching exhaustion.

The ethane present is burned in the explosion and is reported as methane, increasing the per cent. of methane slightly, and lowering to the same extent the percentage of hydrogen and of nitrogen; but in ordinary work, and in the calculation of the calorfic value of a gas, the effect of the presence of small quantities of ethane is negligible.

Ethane may, however, be readily determined separately if it is desired. The hydrogen must first be separately removed by means of a palladium tube. This is done by adding to 10 cc. of the residual gases oxygen and air just as directed above for the explosion.

The palladium tube is installed between the burette and the storage bulb. A beaker containing water, which is kept at the boiling point by a Bunsen lamp, is so placed as to have the loop of the tube immersed in the hot water. An accurate reading of the amount of mixture is then taken and the mixture passed very slowly through the tube into the storage bulb and then back. Care must be taken not to pass the gas through the tube too rapidly, or the heat generated is apt to break up some of the methane. The palladium does not really absorb the hydrogen from the mixture, but by a catalytic action causes it to combine with the oxygen present and form water, and hence $\frac{2}{3}$ of the contraction, due to passage of the mixture over the palladium, is the percentage of hydrogen. The known volume of mixture after the hydrogen absorption is then exploded and the contraction noted. A second contraction, due to the absorption of the carbon dioxide by KOH formed, is also noted. The volumes of the methane and ethane may then be calculated from the following formulæ, where

First contraction, due to condensation of water vapor formed, and

Second contraction, due to absorption of carbon dioxide formed.

Per cent. by volume of CH_4 =

$$\frac{4 \times (\text{1st contraction}) - 5 \times (\text{2d contraction})}{3} \times \text{constant.}$$

Per cent. by volume of C_2H_6 =

$$\frac{4 \times (\text{2d contraction}) - 2 \times (\text{1st contraction})}{3} \times \text{constant.}$$

The difference between the sum of all the percentages found by the above determinations and 100 is the percentage of nitrogen.

Solutions.—1. The potassium hydrate, or hydroxide solution, is made by dissolving 5 parts by weight of chemically pure potassium hydroxide (purified sticks) in 100 parts by weight of distilled water. This solution should be kept in well-stoppered bottles, using rubber stoppers to prevent sticking and deterioration of solution due to absorption of carbon dioxide from the air. The same hydrate solution is used for the absorption of CO_2, of bromine fumes and with the pyrogallic acid for oxygen, and of CO, after methane. The hydroxide which comes marked "Pure by lime" is better for this use than that marked "Pure by alcohol."

2. The pyrogallic acid solution is made by dissolving 10 parts by weight of chemically pure pyrogallic acid in 100 parts by weight of distilled water. To every 1,000 parts by weight of this solution add 5 parts by weight of oxalic acid as a preservative. Do not mix the pyrogallic acid solution with the potassium hydrate solution, except in the funnel, and until quite ready for use, as the potassium pyrogallate thus formed will absorb oxygen from the air and lose its strength. At least 2 minutes should be given the oxygen absorption with potassium pyrogallate when flue gases or engine exhaust are being analyzed.

3. The copper monochloride solution is made by dissolving 75 parts by weight of chemically pure copper monochloride in 720 parts by weight of concentrated hydrochloric acid, to which has been added 400 parts by weight of distilled water. Ten or 20 grams or more of clean, bare, copper wire or foil should be added and kept constantly in the bottle with the mixture, to prevent deterioration. When a small quantity of the solution is added to a large amount of water a cloudy white precipitate of copper monochloride appears. When n cloudiness is thus produced, and the mixture shows a blue tint, the preparation has become oxidized and is unreliable.

4. Gas saturated distilled water may be prepared by means of the apparatus shown in Fig. 7 at a temperature not less than, and preferably a few degrees above, that at which it is to be used, so as to avoid evolution of the dissolved gases in the burette.

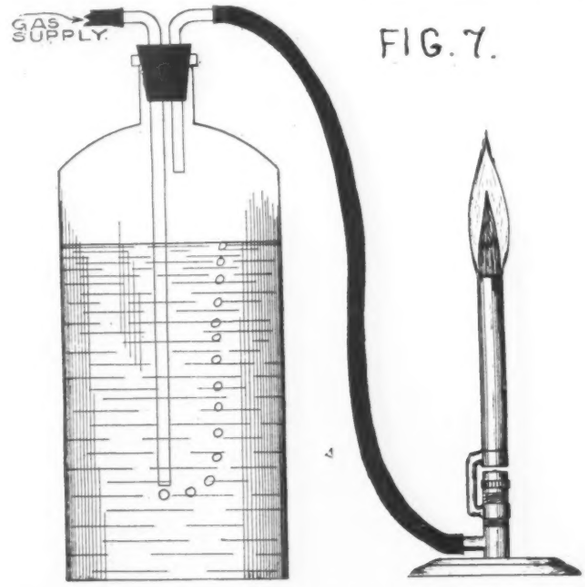

FIG. 7.

5. Distilled water may be sufficiently aerated by shaking it vigorously for 2 or 3 minutes in a large bottle ¾ full of distilled water.

Apparatus.—6. The apparatus may be cleaned from time-to-time by running through it a solution of potassium bichromate in sulphuric acid. This is useful when the platinum points become coated with carbon. This cleaning solution should be used with care, as sudden mixing of the sulphuric acid solution with the water in the burette generates considerable heat, which may break the burette.

7. For constant use it is well to install the water-jacketed burette, as shown in plate, by means of clamps attached to a permanent pipe stand supporting a shelf over a sheet lead drain. The electrodes (13) leading from burette (4) are insulated from water-jacket (11) by rubber tubing, containing copper wires fused to the platinum leads and leading to the terminals of a ¼-inch spark coil, operated by at least two ordinary dry batteries (not shown in plate). A drain funnel (12) connected by rubber tubing to a glass tube (18) of ¼-inch bore extending to sink or drain pipe, will be found of great convenience in a permanent installation for getting rid of waste from funnel or cup (5). A drain tube (20) leading from bottom of bottle (10) upward and curved in a semi-circle at the top, so that the outlet is level with the desired water level in the bottle (10), will be found advantageous in securing cleanliness.

8. Rubber tubing 14, 15, 16 and 17 should be of the heavy-wall, pure gum variety, and of such internal diameter as to give tight joints over the glass tubing etc. The joints should be wired to insure freedom from leaks incident to loosely attached tubing.

9. By keeping the apparatus and all of the bottles filled with water, especially when not in use, and the reagent bottles in immediate proximity, the entire outfit acquires about the temperature of the room, and the error arising from the source of temperature changes in the sample is eliminated.

10. The explosions take place in the measuring burette. A coil which will give a ¼-inch spark is ample. Too strong a spark is apt to crack the glass, as is a continuous play of sparks between the points, or a play of sparks when the burette is dry. If the explosion does not occur simultaneously with the first spark the spark need not be continued. Something else is wrong. The usual trouble is that the combined mixture is not an explosive one and the proportion of air or oxygen to gas residual must be changed.

11. The reagent funnel (5) and top ground joint of burette should be washed well after the completion of each analysis to prevent stick-

ing at the ground joint, due to any potassium hydrate solution which may be present. This rule is applicable also to other movable parts, such as cocks which are likely to stick.

12. The bulb (6), which is not graduated, is used to hold the excess of gas when the explosion is being made. The analyst occasionally loses an explosion, and were it not for the gas held in this bulb the entire analysis would have to be made over. By putting into the bulb all of the gas that is left after the CO absorption, except the 10 cc. which is used for the explosion, several explosions may be made as checks on one another, or in case the first one is lost.

13. If the cocks stick they can usually be loosened by a little hot water on the outside. They should be kept well lubricated with a mixture of equal parts of vaseline, tallow and paraffine.

14. For getting samples, it is best to get four sample cans. The sketch here will show what these are. In getting the sample the can is placed in an upright position and filled quite full of water, perfectly saturated with the gas to be sampled in order to expel all of the air. A tube connected with the upper stop-cock is then introduced into the space from which the gas sample is to be drawn, and the lower stop-cock is opened, allowing the water to run out, and thus the sample is aspirated into the can. In drawing samples from places which have a suction instead of a pressure, such as the inlet of an exhauster, or at the base of a stack, or in the breeching of a boiler, the water should be allowed to flow out through a U-shaped glass tube attached by a piece of rubber hose to the lower stop cock. If this is not done, after the water is all out, air will enter and spoil the sample. It is essential to draw out all of the water, even if only a small sample is required, as a number of the constituents, illuminants and CO_2, for example, are soluble in water. If the gas to be sampled is under pressure it is well enough to allow it to flow through the can for a few seconds after all of the water has run out.

To get the sample out of the can, the lower stop-cock is connected by a hose with a source of water under pressure such as an aspirator bottle filled with water and placed at a level above that of the sampling can, and as the water runs into the can the gas will be displaced and may be led by means of a hose to the burette.

15. The principal precaution necessary in gas analysis is to see that the temperature of the apparatus and of the water used, and of any additional water which may be added, as well as the temperature of the sample undergoing examination, does not change during the analysis. A change of 5.2° F. will cause a change of about 1 per cent. in the volume of any gas at an ordinary temperature of 60° F. The temperature at which an analysis is made is immaterial, but that temperature must remain constant.

16. In reading the burette, hold leveling bottle (7) in front and just to one side of the burette, so that the eye of the analyst can sight along the under surface of the water level in (7) and bring it in the same horizontal plane with the bottom of the meniscus in the burette, as shown in Fig. 8.

Analysis.—The quantities of reagents and wash water described in the foregoing method of analysis are intended mainly for the analysis of carburetted water gas, hence in the analysis of any other gas the quantities specified should be changed if it is found to be necessary in order to insure complete absorption of the various constituents. This is also true of the oxygen and air required for explosion.

18. Introduce potassium hydrate solution slowly for first absorption, as the tendency otherwise is to secure too high a percentage for the carbon dioxide.

19. Care should be taken in handling bromine. Keep it always under water, not allowing it to come in contact with the skin. Bromine is an exceedingly energetic reagent and will cause painful chemical burns. If bromine fumes are breathed, relief from the irritation caused to the throat can be obtained by inhaling alcohol or steam. The slick feeling caused by getting potassium hydrate on the hands may be removed by a little dilute hydrochloric acid.

20. The absorption of illuminants by bromine is a heat-producing reaction, and the increased temperature is apt to cause the sample to expand unduly and may cause the loss of a part of the sample by forcing it out through cock (1) and thus vitiate the analysis. If it is seen that the expansion is becoming excessive a little water may be added from (8). The bulb at the lower end of the burette is provided for this emergency, however. In the analysis of acetylene, which contains over 90 per cent. of illuminants, this is especially apt to occur. If the percentage of illuminants is high, it is well to admit a little water from (8) during the absorption with bromine, to restore the normal temperature of the gas.

21. Twenty cc. of potassium pyrogallate solution, when mixed with

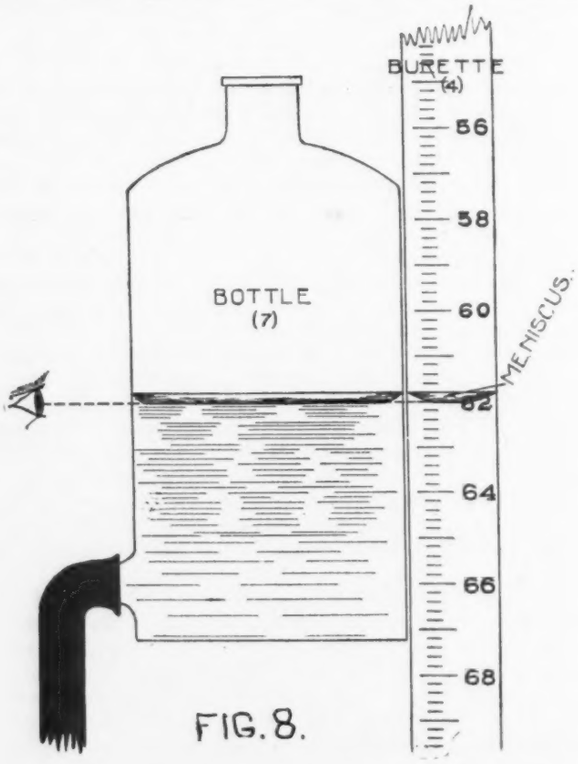

FIG. 8.

20 cc. of potassium hydrate solution, produces a rise in the temperature of the mixture of about 5° F. over that of the original solutions. The heat gained by the gas in the burette due to this cause should be taken into consideration and sufficient time allowed the burette gases to resume initial temperature before reading. This solution should be passed into the burette very slowly, as the absorption of oxygen is rather sluggish. The absorption may be considered complete when no further discoloration to purple or brown occurs upon introduction of the clear reagent.

22. The absorption of the last traces of CO is attended with difficulty, and hence the analyst should be careful to add sufficient copper monochloride solution and allow plenty of time for the complete absorption. The reagent being strongly acid, about 10 cc. of potassium hydrate solution should always be added, after passing in about 50 cc. of wash water, to insure removal of all fumes of hydrochloric acid and followed with the customary wash water.

23. When carburetted water gas is being analyzed, double quantities of residual gases, oxygen and air may be taken for the explosion in order to secure higher accuracy.

24. Prior to all explosions sufficient time, at least two minutes, should be allowed for the gases to thoroughly diffuse through the oxygen and air added, so as to give a homogeneous explosive mixture and insure the combustion of all the oxidizable gases.

25. No special care need be taken in measuring the amount of air or of oxygen added for the explosion, though the amounts taken should not be less than those stated in the "Method." Care must be taken, however, to measure accurately the amonnt of gas taken for the explosion, and the total amount of the gas, air and oxygen just before the explosion.

26. Air is added to the mixture to be exploded merely to lessen the jar. If the gas is very poor, or contains large quantities of nitrogen, no air need be added, and on the other hand, if the gas is quite rich, no oxygen need be added, air being sufficient, although if oxygen is available it is best added to insure combustion. An excess of oxygen used with a very rich gas, such as acetylene, or a high candle power Pintsch, water or coal gas, may result in the oxidation of some of the nitrogen; but this is not very apt to occur. With extremely poor gas, such as blast furnace gas and the like, no explosion will take place, even when oxygen is used and no air added. Oxyhydrogen gas may be necessary in such cases. This is made by the electrolysis of water slightly acidulated with sulphuric acid. Five to 10 cc. of the oxygen and hydrogen mixture added, in addition to the oxygen, will always insure an explosion. As it recombines to water no special reading or note of the volume added need be made.

27. Use only C. P. chemicals.

General Notes.—28. Never allow the funnel to become entirely empty; always keep about ¼ inch of water or other liquid in the bottom to prevent the suction of air into the burette.

29. In acetylene, flue, engine exhaust, air and gasoline gas there is no hydrogen or methane, hence the analysis need not be carried beyond the absorption with copper monochloride for CO, and the oxygen tank or apparatus, the electric coil, batteries, etc., need not be provided. In analyses of these gases the sum of the first four contractions subtracted from 100 gives the percentage of nitrogen.

30. Where many analyses are to be made, or where dispatch is an important element, it will be more satisfactory to obtain a cylinder of compressed oxygen for use in the hydrogen and methane determinations, but where the apparatus is to be moved from place-to-place, or is to be used only occasionally, or where the analyses are confined for the most part to gases which do not contain hydrogen or methane, such as flue gases, acetylene, air, engine exhaust, etc., a cheaper and quite satisfactory substitute can be had in a small retort, by means of which oxygen can be generated on the spot as needed. To generate oxygen this retort is filled not more than half full with a pulverized, thoroughly mixed, charge of potassium chlorate and manganese dioxide, in the proportions of 20 of the first to one of the latter, by weight. This is heated gently over a bunsen lamp. The evolution of oxygen begins at once and it may be led to the burette by means of a rubber tube. As 100 grams of potassium chlorate will produce 27,600 cc. of oxygen, and only about 20 cc. of oxygen are used for one analysis, a very small spoonful of the mixture will suffice for a great many explosions.

31. The method of analysis is so laid out that each determination must be made in its turn. With the exception of the absorption of CO_2 with KOH, and possibly that of CO with cuprous chloride, no isolated determination of any one constituent can be made with anything approaching accuracy, without starting at the beginning and making all of the absorptions down to that constituent.

Careful readings of the burette should be taken before and after each determination, and especial care should be taken in making the analysis to thoroughly absorb each constituent in its turn. Partial absorption, or errors in the readings, will not only introduce an error in the percentages of the constituent in question, but the remaining portions of this constituent will affect the latter determinations in the analysis and thus have a doubly vitiating effect upon the accuracy.

Any CO_2 left after the first absorption will be absorbed by the KOH following the bromine, and will be reported as illuminant, or if by chance it is not absorbed by the KOH following the bromine, it will be absorbed by the alkaline pyrogallate solution used for oxygen absorption and will appear as O_2.

Any illuminant not absorbed will remain and burn to approximately 3½ times its volume of CO_2 when the explosion is made and will appear as CH_4. A very small proportion of illuminant left and burned and calculated to CH_4 will be sufficient to run the total of the analyses to more than 100 per cent. Any bromine vapors left after the absorption with bromine will be absorbed by the pyrogallate solution and will be reported as O_2.

Any unabsorbed CO will be burned to CO_2 in the explosion and will decrease the percentage of H_2 and CH_4, and increase the percentage of N_2 to the same extent. Any unabsorbed O_2 left would decrease the percentage of H_2 and CH_4, and increase the percentage of N_2 to the same extent. Any unabsorbed CO_2 after the explosion will decrease the percentage of CH_4 and increase that of the H_2 and N_2.

The N_2 being determined by difference will necessarily show the net effect of any and all errors in either readings of the burette, or in the performance of the analysis.

Interpretation.

To draw any trustworthy conclusions from a gas analysis, it is necessary to consider the analysis as a whole, rather than to base conclusions merely on the variation of the proportion of some one constituent from a standard figure that practice has taught to be normal.

For example, the candle power of a coal or water gas may be said in a general way to vary with its percentage of illuminants, but it is not unusual to have a gas showing a high illuminant content, and at the same time a low candle power on account of the percentage of carbon dioxide, oxygen or nitrogen, which neutralizes the effect of the illuminants; and, conversely, a low illuminant content may coexist with a high candle power if the percentage of the impurities is low.

The following statement, in regard to inferences to be drawn from the excess or deficit of any one constituent in an otherwise normal analysis, must be taken with the understanding that the analysis is otherwise normal, and that the good (or bad) effect of the excess or the deficit of any one constituent is not neutralized by the undue presence or absence of one or more of the other constituents. The following figures are not given as absolute standards for all cases, but are averages, of those figures which, under certain local conditions, obtain in the best practice. Conditions and requirements will vary the analysis in individual instances, and space is left in each line in which may be inserted as a standard for comparison the average figures of a number of analyses taken at times when practice and experience prove conditions to be at their best. The following gases are discussed:

Acetylene ... Air[1] ... Blast furnace gas ... Blue water gas ... Coal gas ... Electric furnace gas ... Engine exhaust[2] ... Flue gas[3] ... Gasoline gas ... Gas leaks ... Limekiln gas ... Mine gas ... Natural gas ... Pintsch gas[4] ... Producer gas ... Sewer gas ... Waste gases ... Water gas ....

The term "Methane," as used in connection with such gases as carburetted water gas, coal, Pintsch, natural and gasoline gas, includes "ethane" and the other higher hydrocarbons of the methane series.

All figures given are for dry gases at 60° F. and 30 inches of mercury.

The percentages are for volume—not weight—and where the same applies, for combustion in air, not oxygen.

Gas Leaks.

Analyses of the air in connection with gas leaks, to determine the nature of the gas and extent of the leaks where there is merely an odor, are, almost without exception, futile. One per cent. of almost any gas mixed with air is sufficient to give a strong odor, $\frac{1}{10}$ of 1 per cent. being sufficient with some gas, while no accurate analysis can be made of an air mixture having less than 3 per cent. of the complicated mixture which we call an industrial gas.

Acetylene.—Commercial.

Carbon dioxide	....	per cent.
Illuminants	96.00	"
Oxygen	0.75	"
Carbon monoxide	....	"
Hydrogen	....	"
Methane	...	"
Nitrogen	3.25	"
	100.00	"
B.T.U. per cubic foot	1,400	
Specific gravity	0.90	

Acetylene should show 100 per cent. illuminants, but it is almost impossible in ordinary work to get it entirely free from air. The variation of the illuminant content from 100 per cent. shows the extent of the air mixture, and this is checked if the oxygen and nitrogen found are in the 1 to 4 proportions of air.

If acetylene has been heated in generation, or in other ways, to a temperature in excess of 538° F., it will be broken up or polymerized into some higher hydrocarbons, which are not soluble in bromine and which will appear later as methane. Or, if the temperature has been quite high, acetylene will break down completely into hydrogen and carbon. The presence of either methane or of hydrogen in any appreciable quantities in commercial acetylene is evidence of excessive temperature at some part of the process.

Blast Furnace Gas.

Carbon dioxide	12.8	per cent.
Illuminants	....	"
Oxygen	0.1	"
Carbon monoxide	26.5	"
Hydrogen	3.5	"
Methane	0.2	"
Nitrogen	56.9	"
	100.0	"
B.T.U. per cubic foot	100.0	
Specific gravity	1.01	

In the above analysis the carbon dioxide comes from the complete combustion of the fuel, or the secondary combustion of some of the carbon monoxide, resulting from the reducing action in the cupola. As evidence of good fuel and heat economy the higher the carbon dioxide the better, but if the gas is to be subsequently used for burning, or in gas engines, its presence is a detriment. The reducing

1. See paragraph under "Constituents." 2. See "Waste Gas."
3. *Ibid.* 4. See Coal Gas.

reaction of the carbon of the fuel on the iron oxide would produce carbon monoxide, which, in the presence of air, would burn to carbon dioxide. Any oxygen occurring in blast furnace gas would be the evidence of a leak. Carbon monoxide would come from the reducing action in the furnace or from moisture in the fuel, in the charge or in the blast, which would react with the hot carbon to form carbon monoxide and free hydrogen.

Hydrogen would be formed from moisture, and its presence would be evidence of water, or possibly of some volatile matter left in the coke, which latter would also be evidenced by the presence of methane. Methane would show that, in addition to there being volatile or organic matter present, the temperature was low.

Nitrogen is left from the air of the blast, and while it is a detriment and to be kept as low as possible, its presence in about the quantity shown is unavoidable.

BLUE GAS.—Uncarburetted Water Gas.

Carbon dioxide	3.00	per cent.
Illuminants	....	"
Oxygen	....	"
Carbon monoxide	43.25	"
Hydrogen	50.00	"
Methane	0.50	"
Nitrogen	3.25	"
	100.00	"
B.T.U. per cubic foot	308.0	
Specific gravity	0.53	

This gas is the result of the reaction described by the formula

$$C + H_2O = H_2 + CO,$$

which takes place when steam is passed through hot carbon. If the reaction were perfect this gas would consist of practically 50 per cent. each of hydrogen and carbon monoxide, but there must be some air present and some carbon dioxide formed.

The carbon dioxide comes from air mixed and monoxide burned to carbon dioxide or from the reaction itself. Its presence is evidence of an air leak or of too low, too cold or too shallow a fire, or a fire with dead spots, or an excess of steam, or steam which in some way has gotten through the fire and combined with the carbon monoxide to give carbon dioxide and hydrogen according to this formula:

$$CO + H_2O = CO_2 + H_2.$$

As in all industrial gases intended for burning the presence of CO_2 is a detriment, although its absence or very low percentage would be evidence of an underloaded condition of the machine and its elimination is not to be pursued too far. Carbon monoxide comes from the reaction described; a deficit, if accompanied by an excess of carbon dioxide, is evidence of steam having passed through the fire.

An excess of hydrogen is evidence of some hydrocarbon in the fuel or of a steam leak through the fire. A deficit of hydrogen, if accompanied by an excess of nitrogen, is evidence of an air leak.

A small percentage of methane may come from volatile matter in the fuel along with insufficient heat to break this down into carbon and hydrogen.

Nitrogen comes from the air added, entrained or dissolved.

COAL GAS.

	Coal Gas (16-c. p.) Per Cent.	Pintsch Gas, Per Cent.
Carbon dioxide	2.5	0.5
Illuminants	4.0	23.5
Oxygen	0.5	0.5
Carbon monoxide	7.5	1.0
Hydrogen	45.0	18.5
Methane	35.0	52.5
Nitrogen	5.5	3.5
	100.0	100.0
B.T.U. per cubic foot	616.0	1,200
Specific gravity	0.45	0.71

The carbon dioxide in coal gas or Pintsch gas comes, either from an air leak in some hot part of the process through which air is drawn, the oxygen of which, burning to carbon dioxide, or more likely a leak in a retort or connection through which stack gases from the bench fire are drawn. Carbon dioxide constituent should be kept as low as possible.

The illuminants come from the distillation of the coal or of the oil, and to this constituent is due a large part of the calorific and practically all of the illuminating value. An excess of it would mean—especially along with a deficit of methane—too low heats or too short a time of carbonization. An excess would show a good gas, but would evidence an underloaded, or underheated condition and an uneconomical operation. A deficit of illuminants, if accompanied with excess methane, would show too high heats; or, if with an excess of hydrogen, very excessive heats.

An excess of oxygen would mean an air leak at some part of the process after the gas was cooled below the ignition point. It might mean a leaky exhauster connection or too much air for purification. A small percentage of free oxygen should be present as evidence of sufficient air for purification; but, aside from this, the lower the oxygen content the better, especially as oxygen almost invariably comes from the air and carries with it 4 times its volume of inert nitrogen. A deficit of total absence of any free oxygen means insufficient air for purification.

Carbon monoxide comes from the partial combustion of carbon with oxygen mixed or entrained with the coal or oil, or from water or moisture which breaks up and forms carbon monoxide and hydrogen. An excess would mean an air leak in some hot part of the process, or more likely water or moisture. As water would form this blue gas at the expense of the best part of the illuminants, the presence of an excess of carbon monoxide, especially if accompanied with high hydrogen, may be regarded as an indication of uneconomical conditions. A deficit of carbon monoxide would mean too low heats.

Hydrogen in coal gas or Pintsch gas may come from either the breaking up of water by hot carbon, or from the breaking down of hydrocarbons by heat. An excess of hydrogen, if accompanied by an excess of carbon monoxide, would mean wet coal or water mixed with the oil; if not so accompanied, would mean too long carbonization, insufficient charge, or excess heats, as any hydrocarbon will break down into hydrogen and lampblack if heated sufficiently high. A deficit of hydrogen would mean low heats or an underloaded condition of the retorts. Methane comes from the hydrocarbons which have been subjected to temperatures too high to result in the formation of illuminants and not high enough to produce free hydrogen. An excess would mean too high heat or too long carbonization, especially if accompanied with hydrogen.

Nitrogen comes from the air for the most part and its presence is evidence of a leak or of some other condition which should not exist. A certain percentage is unavoidable, especially as some air must be added to the gas for purposes of purification; but the proportion should be kept as low as practicable. An excess of nitrogen would mean an air leak; if accompanied with high carbon dioxide or low hydrogen, it would mean air or products of combustion mixed while the gas was hot; if accompanied by high oxygen, it would mean air mixed after gas was cooled.

ELECTRIC FURNACE GAS.

Carbon dioxide	0.5	per cent.
Illuminants	..	"
Oxygen	0.5	"
Carbon monoxide	59.5	"
Hydrogen	24.5	"
Methane	1.5	"
Nitrogen	13.5	"
	100.0	"
B.T.U. per cubic foot	287.0	
Specific gravity	0.75	

The above is an analysis of the gases given off in an electric furnace where the heat is supplied by electricity instead of by combustion of the fuel, and carbon is used as the reducing agent for some refractory oxide. If the mixture were pure and there was no air present the analysis would show 100 per cent. carbon monoxide. The carbon dioxide present comes from the burning of the gas with air mixed after the gas has been cooled or was away from the presence of hot carbon. The oxygen comes from air leakage. The carbon monoxide is the result of the reducing reaction of the process, or of oxygen from the air, or in the mixture combined with the carbon, or from water or moisture broken up by the hot carbon to form carbon monoxide and hydrogen. The hydrogen is from water or moisture as above, or from the breaking down of some hydrocarbon in the mixture. The methane is from the partial breaking down of some hydrocarbon. The nitrogen is from air leaked in or entrained with the mixture.

GASOLINE GAS. "Greased Air."

	For Burning Per Cent.	From Engine Carburetter (Explosive mixture) Per Cent.
Carbon dioxide	..	....
Illuminants	1.5	0.6
Oxygen	18.5	17.7
Carbon monoxide	....	....

	For Burning Per Cent.	From Engine Carburetter (Explosive Mixture) Per Cent.
Hydrogen	....	....
Hexane C_6H_{14}	10.3	2.9
Nitrogen	69.7	78.8
	100.0	100.0
B.T.U. per cubic foot	514.0	145.0
Specific gravity	1.22	1.02

Gasoline gas or carburetted air consists of air more or less saturated with gasoline vapors. These vapors consist of a mixture of ethylene C_2H_4 and hexane—one of the methane group—C_6H_{14}. The direct determination of the hexane is rather complicated, and as the oxygen and nitrogen are always in the proportion of air, a very accurate analysis can be arrived at by determining the hexane by difference. The analysis is performed by determining the illuminants and oxygen in the regular way. Now, as the nitrogen content comes from this air, and being unchanged is equal to 3.77 times the oxygen content, its proportion can be calculated. The difference between the sum of all the other constituents and 100 would be the percentage of hexane.

An excess of either illuminants or hexane which come from the gasoline would mean an excess of gasoline or a deficit of air used, which would result in a smoky flame, blackened mantle, or condensation and deposit of this hydrocarbon in the pipes. If sample is taken from the carburetter of an engine, an excess would result in smoke or soot in the exhaust, carbon deposit in the cylinder and on the plugs, misfiring and lowering of capacity.

A deficit of either of these would mean a low candle power, due to too little gasoline, too much air or not the right "number" or adjustment on the gas machine, or an overload on the system. In an engine mixture a deficit would result in back-firing, pre-ignition and explosion in muffler or exhaust system and loss of power.

Lime Kiln Gas.

Carbon dioxide	35.0 per cent.
Illuminants	..
Oxygen	2.0 "
Carbon monoxide	0.5 "
Hydrogen	..
Methane	..
Nitrogen	62.5 "
	100.0 "
B.T.U. per cubic foot	..
Specific gravity	1.17

The carbon dioxide in this gas comes from both the combustion of the fuel and from the reduction of the limestone—calcium carbonate—which is being burned to lime—calcium oxide. The higher percentage of carbon dioxide the better, a deficit would show an underloaded condition, or insufficient fuel and heat.

The oxygen would come fromthe air through the fire, and, as in other waste gases, a small excess is essential to insure complete burning of the fuel. The free oxygen, however, should be kept as low as possible not to produce carbon monoxide which would be evidence of incomplete burning.

Carbon monoxide comes from partially burned fuel and is evidence of poor fuel economy.

The nitrogen is left after the oxygen of the air is burned out.

Mine Gas.

Carbon dioxide	3.0 per cent.
Illuminants	.... "
Oxygen	6.5 "
Carbon monoxide	1.0 "
Hydrogen	5.5 "
Methane	59.5 "
Nitrogen	24.5 "
	100.0
B.T.U. per cubic foot	622.0
Specific gravity	0.70

The above is an analysis of a sample taken from a closed passage in a coal mine. It shows natural gas with about 30 per cent. air mixture. Such a mixture would be asphyxiative, and if mixed with more air would become explosive. It shows an almost complete absence of ventilation. (See Natural Gas.)

Natural Gas.

Carbon dioxide	2.0 per cent.
Illuminants	0.4 "
Oxygen	0.4 "
Carbon monoxide	0.5 "
Hydrogen	1.6 "
Methane	93.5 per cent.
Nitrogen	1.4 "
	100.0
B.T.U. per cubic foot	960.0
Specific gravity	0.58

Natural gas comes from great depths in the ground, and its composition and proportions vary very widely with different wells and localities, and the proportions are not controllable, except possibly for oxygen and nitrogen drawn in as air where the wells are pumped and are under suction. Carbon dioxide often occurs along with the gas.

Illuminants as oil vapors are found, especially where the wells are nearing exhaustion, and in such cases sulphuretted hydrogen and carbon dioxide are apt to appear or the proportion to increase.

Methane is the active principle in natural gas, and the other constituents may be regarded as impurities or diluents. The higher the percentage of methane the more valuable is the natural gas.

Producer Gas.

Carbon dioxide	6.0 per cent.
Illuminants	.... "
Oxygen	.... "
Carbon monoxide	22.0 "
Hydrogen	11.0 "
Methane	3.0 "
Nitrogen	50.0 "
	100.0 "
B.T.U. per cubic foot	138.0
Specific gravity	0.89

Carbon dioxide is to be avoided in producer gas. Its presence is evidence of too low a fire, of a coal fire, or one with dead spots in it, of an overloaded machine or of an excess of air. An absence or a great deficit of carbon dioxide would show that the machine was underloaded and not operating up to its capacity.

Carbon monoxide and hydrogen are produced when the conditions are best, and the opposite of those conditions which produce carbon dioxide result in a high carbon monoxide and hydrogen content and evidence good practice. Low hydrogen with high nitrogen shows an excess or leak of air, as the hydrogen in the gas combines with the oxygen in the air and disappears as water vapor leaving the nitrogen. Methane is produced when the heats are low or the machine is underloaded, and, while it adds greatly to the value of the gas, its presence may be taken as evidence that the full capacity is not being gotten from the producer, and that either there is not sufficient steam and air or the fire is too cold or too shallow. Between 50 per cent. and 60 per cent. of nitrogen is unavoidable in producer practice, although, as in every industrial gas, the presence of nitrogen is a detriment. An excess of nitrogen, especially if accompanied by an excess of carbon monoxide, or a deficit of hydrogen, is evidence of an excess of air.

Sewer Gas.

Carbon dioxide	3.10 per cent.
Illuminants	.... "
Oxygen	12.01 "
Carbon monoxide	1.80 "
Hydrogen	.... "
Methane	1.70 "
Nitrogen	78.22 "
Sulphuretted hydrogen	3.17 "
	100.00 "
B.T.U. per cubic foot	144.00
Specific gravity	1.002

The poisonous effects of air or gas from sewers, cesspools and the like are due to the sulphides of ammonium or of hydrogen, although asphyxiation may occur solely from the want of oxygen. Sewer gas usually contains methane and carbon monoxide produced by decay, to which, along with hydrogen sulphide, any combustion or explosion of this gas is due. The proportions of the different constituents of sewer gas vary over very wide ranges according to the amount of ventilation.

A fair average analysis, however, would be about as stated above. The most satisfactory means of identifying sewer gas is by a qualitative test for sulphuretted hydrogen, made in the well known way with test paper wet with a solution of acetate of lead.

Waste Gas.

	Flue or Chimney Gas (Soft Coal). Per Cent.	Gas Engine Exhaust (25-C. P. Water Gas). Per Cent.
Carbon dioxide	13.5	8.9
Illuminants	....	....

	Flue or Chimney Gas (Soft Coal). Per Cent	Gas Engine Exhaust (25-C. P. Water Gas). Per Cent.
Oxygen	5.5	7.7
Carbon monoxide	....	....
Hydrogen	....	....
Methane	....	....
Nitrogen	81.0	83.4
	100.0	100.0
B.T.U. per cubic foot	...	....
Specific gravity	1.05	1.04

The higher the percentage of carbon dioxide in flue gas or engine exhaust, the more perfect the combustion and the better the conditions. Air contains practically 21 per cent. by volume of oxygen. When oxygen combines with carbon to form carbon dioxide, it produces its own volume of carbon dioxide; hence, if carbon is burned to carbon dioxide with oxygen from the air the sum of the uncombined oxygen and the carbon dioxide produced must equal 21 per cent. of the volume of the products of combustion.

When oxygen combines with carbon to form carbon monoxide, it produces twice its volume of this gas; hence, if carbon were partially burned in air, and produced both carbon dioxide and carbon monoxide, then the formula, $CO_2 + \frac{1}{2} CO + O = 21$ per cent., would be correct and might be used as a check on the accuracy of an analysis where coke or hard coal is used as a fuel.

The use of such a formula, however, as a check on any waste gas analysis, where the fuel contained any proportion of hydrogen (either free or combined) would not answer, as the hydrogen in the fuel combines with the oxygen to form water vapor, and, as this moisture would not appear in the analysis, some of the oxygen will not be accounted for, and the percentage of nitrogen which would go to make up the 100 per cent. would seem unduly high and appear to indicate poor economy, when such might really not be the case. Just the proper amount of hydrogen burned in air would form water with all of the oxygen and give a waste gas analysis showing 100 per cent. free nitrogen.

Incidentally, this fact destroys the accuracy and value of the tables and curves made by those selling continuous flue gas analyzing apparatus, in which the claim is made that the deficit of carbon dioxide below 21 per cent. shows exactly the extent of the imperfect combustion in the boiler.

A deficit of carbon dioxide, with a corresponding increase in nitrogen, if accompanied by a large excess of oxygen, would mean an excess of air, either added or drawn in through leaks, while if unaccompanied by such excess of oxygen would merely show a fuel high in hydrogen. It is impossible to get perfect conditions in commercial boiler or engine practice, and an excess of air shown by a small percentage of free oxygen is essential to insure complete combustion, and is of much less detriment than a deficit of air, which would result in an imperfect combustion of a part of the fuel. As the combustion in an engine cylinder is much more rapid and violent than the combustion in a boiler furnace, a slightly larger excess of free oxygen is advisable in the former than in the latter.

A large excess of oxygen is evidence of too much air in the mixture, or of an over-blown fire. The oxygen should be kept as low as possible without producing carbon monoxide. The analyst must be quite sure, however, that the free oxygen showing in the analysis really came through the engine cylinder or the fire, and did not leak into the flue or the setting, or especially into the sample can after the fire was passed. The importance of this precaution can scarcely be overestimated.

The presence of any carbon monoxide is evidence of insufficient air, incomplete combustion and of inefficient operation. If the conditions of air supply are much worse, methane or even illuminants may appear.

Less than from 3 per cent. to 8 per cent. of free oxygen in waste gas is bad, and the presence of carbon monoxide is worse, while any methane or illuminants at all is simply awful.

When soft coal, oil, gas, or in fact any fuel excepting pure carbon, is burned with air, the hydrogen combines with a portion of the oxygen and does not appear in the analysis at all, its place being taken by nitrogen. The excess of nitrogen in a waste gas over the 79 per cent. which air contains is roughly in proportion to the amount of hydrogen, either free or combined, with the fuel contained. This applies to all hydrocarbons, and also, though in much less degree, to the carbohydrates, such as wood, etc., which, while they do contain hydrogen, also contain oxygen in the proportion of water.

The most reliable rule for waste gas is to see that there is always sufficient free oxygen to insure complete combustion and not such an excess as to evidence over-blowing or over-dilution. The percentage of free oxygen and absence of carbon monoxide is a more reliable guide in boiler or engine practice than the carbon dioxide content.

WATER GAS.—Carburetted, 24-c. p.)

Carbon dioxide	3.0 per cent.
Illuminants	12.0 "
Oxygen	0.5 "
Carbon monoxide	29.0 "
Hydrogen	33 0 "
Methane	18.0 "
Nitrogen	4.5 "
	100.0 "
B.T.U. per cubic foot	672.0
Specific gravity	0.68

There are a number of chemical reactions taking place in a water gas set, some beneficial, some the reverse, and it is only by keeping these properly balanced that the best results can be obtained.

First, the water in the steam is broken up by the hot carbon into monoxide and hydrogen, forming what is commonly called "blue gas." If steam passes through the fire and is mixed with this blue gas a further reaction between the steam and some of the carbon monoxide takes place, forming carbon dioxide and hydrogen. If air is mixed with the hot blue gas, either a part of the hydrogen combines with the oxygen and disappears as water vapor, or a part of the monoxide combines with the oxygen, forming dioxide; in either event leaving the nitrogen of the air.

In the carburetter the changes in the oil depend very largely upon the temperature. If there is not sufficient heat the oil is in a large measure merely volatilized to recondense upon becoming cold instead of being dissociated or cracked into a permanent gas. When the temperature is at the most economical point the oil is broken up into what we call illuminants and methane and a small volume of hydrogen. As the temperature gets too high the illuminants are broken up into methane, carbon and hydrogen. With excessive temperatures the methane, and all the proportions added as oil, will break down into their elements of carbon in the shape of lampblack and free hydrogen. The extent and the mutual balance of these reactions can be told by a study of the analysis.

An excess of carbon dioxide, or acid, would show an excess of steam or poor fuel, or an overloaded machine, a low fire, a cold fire, a shallow fire, an uneven fire or a fire with dead spots. An excess may be due also to a steam leak in the up-and-down valve, or incomplete purging of the machine after the blast.

A deficit or absence of carbon dioxide, while being an advantage in the finished gas, is evidence of too little steam for the temperature and the amount of fire and shows an uneconomical condition of operation on account of the machines being underloaded and not giving their output. A small fire and too little blue gas, along with excessive heat in the checkerwork, will result in a gas showing very little, if any, dioxide, the dioxide produced in the generator being reduced to monoxide with the oil as fuel, which is not at all economical. Very low dioxide is evidence of conditions which produce naphthaline, and while dioxide is an impurity and to be kept low it will not do to crowd it too far toward extinction.

An excess of illuminants shows too little blue gas or too much oil, cold checkerwork or a poor fire, and shows a gas which, while possessing a high candle power and calorific value at the station, will not stand transmission.

A deficit of illuminants shows an excess of blue gas or too little oil, or, if accompanied with excess hydrogen, shows too much heat in the checkerwork.

Excess oxygen shows air added by leak or otherwise after the gas is cold. It may show also an excess of air for purification, insufficient purging after blast, a leaky exhauster or connection, too little water in seal pot, leaks in valves of secondary air system, and especially it may mean carelessness in getting the sample.

An absence of oxygen would mean insufficient air for purification, other than that its room is much better than its company.

An excess of carbon monoxide would mean a good fire. When accompanied with excess hydrogen it means steam mixed with the oil gas.

A deficit of monoxide, when accompanied with excess dioxide, and especially an excess of nitrogen, shows an air leak while the gas is still hot.

An excess of hydrogen would show overheated checkerwork and

breaking up of oil, especially when lampblack appears on the water of the seal pot.

A deficit of hydrogen shows insufficient steam or too little fire, or, if accompanied with excess nitrogen, it shows an air leak while the gas is hot.

An excess of methane would mean a low or dirty fire, too little steam, dirty checkerwork or overload, or a cold machine.

A deficit shows excess temperature which breaks up the oil, especially when accompanied with excess hydrogen.

An excess of nitrogen would show air added or mixed or leaked, also insufficient purging, leaky air valves or excess air for purification.

Deficit of nitrogen—there is no such thing as too little of this inert constituent.

The Determination of the Specific Gravity of Gas by the Orifice Method.

The determiuation of the specific gravity of a gas by the "orifice" or "effusion" method is based upon the principle that equal volumes of gases under equal pressures will effuse or flow through small circular orifices at rates such that the squares of the times required are proportional to the respective densities of the gases. Thus the square of the time required for a given volume of gas under any pressure to flow through a given orifice is, to the square of the time required for the same volume of air under the same pressure to pass through the same orifice, as the density of the gas is to the density of the air; or, since the density of air is usually taken as the standard of 1, the square of the time for gas divided by the square of the time for air equals the specific gravity of the gas.

The specific gravity attachment for the burette shown in Fig. 4 consists of a small, hollow, metal nozzle into which is cemented a glass tube, and into the end of this glass tube is fused a thin platinum plate, perforated at its center by a circular orifice of about 1/250 of inch in diameter. For protective purposes when the attachment is not in use a removable metal cap is screwed onto the lower brass piece. The specific gravity attachment is used as follows:

First fill leveling bottle (7) Fig. 5 and burette (4) with about 500 cc. of water well saturated at the temperature of the room with the gas of which the specific gravity is to be determined. Then, after removing cup (5), opening cock (1) and adjusting cock (2) to fully connect bottle (7) with burette (4), slowly raise bottle (4) until the burette is filled to the ground joint at the extreme top. The burette is then ready for the test. Now, attach the hose leading from the sampling can or gas pipe and slowly lower bottle (7) keeping the level of water in same slightly higher than the water level in the burette and thus avoid any possible inward leaks of air. Draw in gas sample until the water level in burette is at least as low as point (19), then close cock (1) and place bottle (7) on shelf (21). Immediately attach the specific gravity device to the top ground-joint of burette, by means of a piece of heavy-walled rubber tubing, about 1½ inches long, and of a bore to fit snugly for at least ½ inch over both the metal tube and the ground-joint of the burette. If the gas is not at the temperature of the burette, allow ample time for it to acquire the temperature of the jacket water (11).

Open fully cock (1) to connect burette with attachment only. Place eye on a level with the 100 cc. burette graduation, and start stop-watch the instant that the bottom of the meniscus of the water level in the burette passes the 100 cc. mark. Allow gas to flow naturally outward through orifice until the bottom of the meniscus of the water level passes the 10 cc. mark in the burette, at which time the stop-watch is stopped and cock (1) immediately closed to further outward flow of gas. Note carefully the elapsed time in seconds and fractions thereof required to pass the 90 cc. of gas. Repeat until at least three consistent runs have been made,

After the last gas run remove the specific gravity attachment, open cock (1) and purge out gas by bringing water level just to top of ground joint. Then lower bottle (7) until a few cc. of air have entered the burette. Now close cock (1) and adjust cock (2) to connect burette (4) with seal bottle (10). Place cup (5) on ground joint and fill with well aerated distilled water, open cock (1) and allow water from cup (5) to flow into burette. Pass in this way at least two cupsfull of water, care being taken not to allow any more air to enter. After the gas saturated water is thus removed from the burette, adjust cock (2) to connect bottle (7) and burette (4), then open cock (1) until the water level just reaches the end of the second joint. Now, lower bottle (7) and draw in air to point (19), close cock (1), place bottle (7) on shelf (21) and allow air to stand a few minutes to complete saturation by water vapor and to attain the temperature of the water-jacket (11), after which follow out the same procedure as just described for the gas. After the respective times (in seconds) have been noted the specific gravity may be calculated as shown in the following examples:

Time in Seconds Required for	Time of Flow. Gas.	Time of Flow. Air.
90 cc.	120.2	152.4
	120.0	152.6
	120.2	152.2
Average	120.1	152.4

120.1 squared or 120.1 × 120.1 = 14,424.01
152.4 squared or 152.4 × 152.4 = 23,225.76

$$\frac{14,424.01}{23,225.76} = 0.621.$$

Notes.—(1) Before making determinations always remove the protective metal cap.

(2) Avoid placing finger on end of glass tube where platinum is situated, as the orifice is readily stopped or damaged by contact. The orifice should be kept clean to give good results.

(3) Always place leveling bottle (7) at the same height when making a determination, and see that the quantity of water contained in leveling bottle (7) hose (14) and burette (4) is the same throughout the tests with both gas and air. The foregoing precautions are essential, as any deviation from the height at which bottle (7) is placed, or quantity of water used in each run, changes the pressure, forcing the gas or air through the orifice and hence give erroneous results.

(4) See that both cocks (1) and (2) are free from foreign matter in the holes drilled in them, and are always open full-wide when they are opened at all so as to give water free and unobstructed passage.

(5) Always keep interior of attachment as dry as possible and free from dust.

(6) Always attach specific gravity device by heavy walled pure gum tubing of appropriate bore so as to make a snug fit and thus avoid errors due to leakage.

Calculation of Calorific Value, Specific Gravity or Density of a Gas from its Analysis.

For all practicable purposes, non-combustible impurities in a gas lower the calorific value of that gas in direct proportion to their presence. That is to say, 50 per cent. of, say, carbon dioxide in a combustible gas will deduct 50 per cent. of the B.T.U. of the pure gas, or in other words, 100 feet of a 50 per cent. mixture of gas and air would have the same heating value as 50 feet of the same gas 100 per cent. pure.

Each of the combustible constituents also affects the calorific value in direct proportion to its presence, and contributes its own proportion of the total calorific value just as if that constituent was burned independently. Knowing the analysis of a gas and the calorific value per cubic foot of the constituents, the calorific value of the whole may be calculated by multiplying the percentage as shown by the analysis by the constant corresponding to each constituent. The sum of these would be the total B.T.U. for the gas.

All of the heating value of an industrial gas is contributed by four of its seven constituents, namely: Illuminants, carbon monoxide, hydrogen and methane, while three, carbon dioxide, oxygen and nitrogen are impurities and detract from the value.

By determining the heating value of chemically pure carbon monoxide, hydrogen and methane, in a Junkers calorimeter, constants for these constituents can be arrived at with great accuracy, but unfortunately such is not the case with the illuminants, as this constituent consists of a number of more or less complicated hydrocarbons, which vary in different gases and under different conditions in the same gas. Hence no one definite constant can be stated which will apply in all cases, but a number of different figures for the different gases must be used.

A constant for the illuminants in any particular gas can be readily calculated and established from the known B.T.U. and analysis of the gas. A considerable number of analyses should be taken, and after deducting from the total B.T.U., as given by the calorimeter, the proportion due to the carbon monoxide, the hydrogen and the methane, according to their well authenticated values, the constant for the illuminants would be the product of the number of remaining B.T.U., divided by the percentages of illuminants from the analysis.

The constants below, for the calorific value and for the density of the respective constituents, are the averages of a very large number of tests made on the respective gases, and by their use the calorific value or the specific gravity—to be within less than 2 per cent. either way from the results given by a calorimeter or by an orifice—can be calculated from a carefully made analysis.

Constituent.	Constant or Gross B.T.U.	Specific Gravity. Density Air—1.
Carbon dioxide	....	1.52
Illuminants in—		
Pintsch gas	2,580	1.61
28-candle power water gas	2,550	1.59
24-candle power water gas	2,412	1.51
Oil gas	2,405	1.50
20-candle power mixed gas	2,370	1.48
16-candle power coal gas	2,308	1.44
Natural gas	1,586	0.98
Gasoline gas	1,586	0.98
Acetylene	1,475	0.90
Oxygen	....	1.1
Carbon monoxide	323	0.97
Hydrogen	326	0.069
Methane	1,009	0.55
Ethane	1,762	1.04
Hexane	4,760	2.97
Nitrogen	....	0.97

For example of a calculation for heating value, take the 16-candle power coal gas analysis (given on page 50) the calculation would be as follows:

Constituent.	Percentage by Volume.		Constant or B.T.U. per Cubic Foot.		
Carbon dioxide	2.5	×	....	=	....
Illuminants	4.0	×	2,308	=	9,232
Oxygen	0.5	×	....	=	....
Carbon monoxide	7.5	×	323	=	2,422
Hydrogen	45.0	×	326	=	14,670
Methane	35.0	×	1,009	=	35,315
Nitrogen	5.5	×	....	=	....
Total	100.0	B.T.U. per 100 cubic feet.			61,639
		B.T.U. per cubic foot			616.4

As the specific gravity of a gas is the specific gravity of its respective parts, its density may be readily calculated from its analysis of the specific gravity of its analysis if the specific gravity of its constituents are known. The densities are given in the table above, and the calculation of the density of the 24-candle power water gas given before is added as an example.

Constituent.	Percentage by Volume.		Density or Specific Gravity.		
Carbon dioxide	3.0	×	1.52	=	4.56
Illuminants	12.0	×	1.51	=	18.12
Oxygen	0.5	×	1.1	=	0.55
Carbon monoxide	29.0	×	0.97	=	28.13
Hydrogen	33.0	×	0.069	=	2.28
Methane	18.0	×	0.55	=	9.90
Nitrogen	4.5	×	0.97	=	4.36
	100.0	Sp. gr. per 100 cubic feet.			67.90
		Sp. gr. per foot			0.68

The following forms for a laboratory log sheet and for a laboratory report will be found convenient.

LABORATORY LOG SHEET. DATE..... ..... 191..

Gas Analyses and Calculations.

Time.....
C. C. and Kind of Gas.

Constituent.	Burette Reading, in C. C.	Per Cent. by Volume.	Calculated Heat Value in B.T.U. per Cu. Ft.		Calculated Specific Gravity.
Carbon dioxide	After absorption by KOH.		000.00	000.00	
Illuminants	After absorption by Br.				
Oxygen	After absorption by Pyro.		000.00	000.00	
Carbon monoxide	After absorption by Cu_2Cl_2				
Hydrogen	Gas for explosion.				
Methane	Mixture before explosion.				
Nitrogen	After explosion.		000.00	000.00	
	After absorption by KOH.				

Specific Gravity Tests.

Time
C.C. and Kind of Gas.

Test Number.	Time of Gas Flow in Seconds.	Time of Air Flow in Seconds.	Time of Gas Flow in Seconds.	Time of Air Flow in Seconds.
1				
2				
3				
Average				
Average squared				
Specific gravity by calculation				

DAILY REPORT OF.....STATION.

LABORATORY.

Day beginning 7 A.M.....191..

Gas Analysis.

Time
Kind of Gas .....

Constituents.	Per Cent. by Volume.	Per Cent. by Volume.	Average. Per Cent. by Volume.
Carbon dioxide			
Illuminants			
Oxygen			
Carbon monoxide			
Hydrogen			
Methane			
Nitrogen			
Total			

Specific Gravity Test.

Time
Kind of Gas.....

			Average.
Specific gravity by orifice method			
Specific gravity by calculation			

Heating Value Tests.

Time
Kind of Gas.....

	B.T.U. per Cu. Ft.	B.T.U. per Cu. Ft.	B.T.U. per Cu. Ft.	B.T.U. per Cu. Ft.	Average. B.T.U. per Cu. Ft.
Heating value in B.T.U. per cubic foot					
Gross B.T.U. by calorimeter					
Gross B.T.U. by Calculation					

APPENDIX A.—BIBLIOGRAPHY.

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APPENDIX B.—SOME DIVERSE CHARACTERISTICS OF ORDINARY GASES.

There is 50 per cent. more difference between the weight of carbon dioxide and hydrogen than there is between the weight of water and mercury, or of lead and white pine.

Nitrogen is an inert, passive, dead substance. Flourine is one of the most energetic substances in nature.

Hydrogen, nitrogen and chlorine are chemical elements. Acetylene, hydrogen-chloride and methane are combinations of two or more elements.

Oxygen is the supporter of both animal and vegetable life, cyanogen is the most actively poisonous substance known to science, or to medicine.

Fire or burning is a combination of fuel with oxygen, carbon dioxide is used as a fire extinguisher.

A gas explosion is a combination or association of oxygen with the fuel. A gunpowder or a dynamite explosion is a dissociation of the nitrogen from the other elements in the explosive.

Hydrogen chloride is an exceedingly strong acid; ammonia is an almost equally strong alkali; methane is neutral.

Carbon dioxide has a negative heat value of 14,500 B.T.U. for each pound of contained carbon. That is, it has 14,500 B.T.U. less than none at all. Hydrogen has a heat value of 62,100 B.T.U. per pound, being greater than that of any other known substance.

Carbon dioxide is so heavy that it can be left for a time in an open bucket, or beaker, or can be siphoned or poured like water from one vessel into another. Hydrogen is the lightest of all substances—is used for balloons—and at the same time in chemical action is just as distinctly a metal as is zinc, copper, iron or silver.

Carbon dioxide will smother a fire. Nitrogen will not burn. Hydrogen burns with a colorless flame, and acetylene possesses 240-candle power.

Oxygen is the most abundant substance in the universe. Argon is so rare as to leave doubts as to its existence.

Methane is practically insoluble in water. Ammonia is absorbed to the extent of 1,000 times the volume of water.

Chlorine may be liquefied and solidified with very meager pressures, and with temperatures well within atmospheric limits. Hydrogen and methane have never been even liquefied, without the most extreme conditions of pressure and refrigeration.

Air, hydrogen and methane are odorless, colorless and tasteless, and can be swallowed or inhaled with impunity. Chlorine has a strong, pungent, unbreathable odor, is greenish in color, and not only cannot be breathed or swallowed, but it produces severe chemical burns if brought in contact with the skin.

Appendix C.—Constants for Calculation of Specific Gravity by Orifice Method.

Time of Flow. Min.	Sec.	Constant.	Time of Flow. Min.	Sec.	Constant.	Time of Flow. Min.	Sec.	Constant.
..	10	100	1	0	3,600	1	50	12,100
..	11	121	1	1	3,721	1	51	12,321
..	12	144	1	2	3,844	1	52	12,544
..	13	169	1	3	3,969	1	53	12,769
..	14	196	1	4	4,096	1	54	12,996
..	15	225	1	5	4,225	1	55	13.225
..	16	256	1	6	4,356	1	56	13,456
..	17	289	1	7	4,489	1	57	13,689
..	18	324	1	8	4,624	1	58	13,924
..	19	361	1	9	4,761	1	59	14,161
..	20	400	1	10	4,900	2	0	14,400
..	21	441	1	11	5,041	2	1	14,641
..	22	484	1	12	5,184	2	2	14,884
..	23	529	1	13	5,329	2	3	15.129
..	24	576	1	14	5,476	2	4	15,376
..	25	625	1	15	5,625	2	5	15,625
..	26	676	1	16	5,776	2	6	15,876
..	27	729	1	17	5,929	2	7	16,129
..	28	784	1	18	6,084	2	8	16,384
..	29	841	1	19	6,241	2	9	16,741
..	30	900	1	20	6,400	2	10	16,900
..	31	961	1	21	6,561	2	11	17,161
..	32	1,024	1	22	6,722	2	12	17,424
..	33	1,089	1	23	6,889	2	13	17,689
..	34	1,156	1	24	7,056	2	14	17,956
..	35	1,225	1	25	7,225	2	15	18,225
..	36	1,296	1	26	7,396	2	16	18,496
..	37	1,369	1	27	7,569	2	17	18,769
..	38	1,444	1	28	7,744	2	18	19,044
..	39	1,521	1	29	7,921	2	19	19,321
..	40	1,600	1	30	8,100	2	20	19,600
..	41	1,681	1	31	8,281	2	21	19,881
..	42	1,764	1	32	8,464	2	22	20,164
..	43	1,849	1	33	8,649	2	23	20,449
..	44	1,936	1	34	8,836	2	24	20,736
..	45	2,025	1	35	9,025	2	25	21,025
..	46	2,116	1	36	9,216	2	26	21,316
..	47	2,209	1	37	9,409	2	27	21,609
..	48	2,304	1	38	9,604	2	28	21,904
..	49	2,401	1	39	9,801	2	29	22,201
..	50	2,500	1	40	10,000	2	30	22,500
..	51	2,601	1	41	10,201	2	31	22,801
..	52	2,704	1	42	10,404	2	32	23,103
..	53	2,809	1	43	10,609	2	33	23,409
..	54	2,916	1	44	10,816	2	34	23,716
..	55	3,025	1	45	11,025	2	35	24,015
..	56	3,136	1	46	11,236	2	36	24,336
..	57	3,249	1	47	11,449	2	37	24,649
..	58	3,364	1	48	11,664	2	38	24,964
..	59	3,481	1	49	11,881	2	39	25,281
2	40	25,600	3	27	42,849	4	14	64,516
2	41	25,921	3	28	43,264	4	15	65,025
2	42	26,244	3	29	43,681	4	16	65,536
2	43	26,569	3	30	44,100	4	17	66.049
2	44	26,896	3	31	44,521	4	18	66,564
2	45	27,225	3	32	34,944	4	19	67,081
2	46	27,556	3	33	45,369	4	20	67,600
2	47	27,889	3	34	44,796	4	21	68,121
2	48	28,224	3	35	46,225	4	22	68,644
2	49	28,561	3	36	46,656	4	23	69,169
2	50	28,900	3	37	47,089	4	24	69,696
2	51	29,241	3	38	47,524	4	25	70,225
2	52	29,584	3	39	42,961	4	26	70,756
2	53	29,929	3	40	48,400	4	27	71,289
2	54	30,276	3	41	48,841	4	28	71,824
2	55	30,625	3	42	49,284	4	29	72,361
2	56	30,976	3	43	49,729	4	30	72,900
2	57	31,329	3	44	50,176	4	31	73,441
2	58	31,684	3	45	50,625	4	32	73,984
2	59	32,041	3	46	51,076	4	33	74,529
3	0	32,400	3	47	51,529	4	34	75,076
3	1	32,761	3	48	51,984	4	35	75,625
3	2	33,124	3	49	52,441	4	36	76,176
3	3	33,489	3	50	52,900	4	37	76,729
3	4	33,856	3	51	43,361	4	38	77,284
3	5	34,225	3	52	53,824	4	39	77,841
3	6	33,596	3	53	54,289	4	40	78,400
3	7	34,969	3	54	54,756	4	41	78,961
3	8	35,344	3	55	55,225	4	42	79,524
3	9	35,721	3	56	55,696	4	43	80,089
3	10	36,100	3	57	50,169	4	44	80,656
3	11	36,481	3	58	56,644	4	45	81,225
3	12	36,864	3	59	57,121	4	46	81,796
3	13	37,249	4	0	57,600	4	47	82,369
3	14	37,636	4	1	58,081	4	48	82,944
3	15	38,025	4	2	58,564	4	49	83,521
3	16	38,416	4	3	59,049	4	50	84,100
3	17	38,809	4	4	59,536	4	51	84,681
3	18	39,204	4	5	60,025	4	52	85,264
3	19	39,601	4	6	60,516	4	53	85,849
3	20	40,000	4	7	61,009	4	54	86,436
3	21	40,401	4	8	61,504	4	55	87,025
3	22	40,804	4	9	62,001	4	56	87,616
3	23	41,209	4	10	62,500	4	57	88,209
3	24	41,616	4	11	63,001	4	58	88,804
3	25	42,025	4	12	63,504	4	59	89,401
3	26	42,436	4	13	64,009	5	0	90,000

(To be Continued.)

Steam Separator Wrinkles.

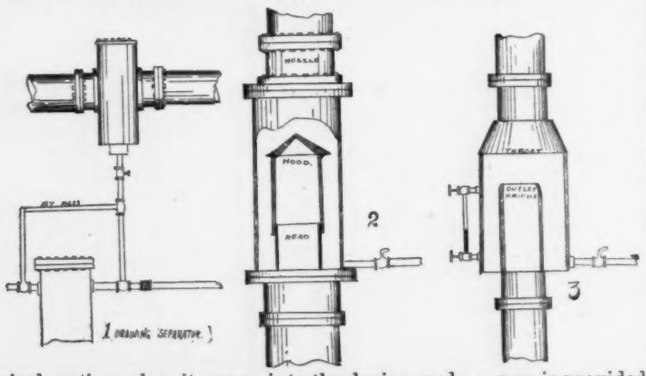
[Prepared for the Journal, by "Engineer."]

The mechanical devices employed for removing moisture from steam are quite numerous, although most of them, however, operate on practically the same principles. The nature of the steam employed determines to what extent the steam separator need be used, so in some plants there is hardly any need of the device, while in others the modern type of steam separator is quite an important item in the generation and application of the steam for power purposes. The presence of a certain percentage of moisture in the steam, under certain conditions, is always troublesome to engineers and firemen; yet in some plants one finds that no provision is made for the remedying of the trouble by the use of the steam separator. I have visited plants in which there are first-class boilers and engines, with all up-to-date attachments for labor-saving purposes and improving the plant in general, only to find that non-effective service is being obtained as a result of excessive percentages of moisture in the steam, and the latter defect tends to make the steam less elastic. The condensation of the steam is affected by the evil, the net thermal value of the steam is reduced every time by the presence of the annoying moisture, "slugs" frequently gather as one result of the presence of the moisture, and the accumulations of water passing through small passages in the pipes and valves are annoying because of frequent clogging and checking. Masses of water collecting anywhere in a boiler are troublesome. Of course, sometimes a steam separator is put on, but even then the desired results are not obtained.

The installation of a separator does not always mean that the steam is going to be properly cleared at once and the efficiency of the boiler improved, as often the device is not attached right, and sometimes the separator is not correctly adjusted. In a certain boiler room, where moisture continued to prevail in the steam even after the separator was put into service, it was found that there was no effective method adopted for draining the separator. The steam separator was set up in the usual way, but the necessary automatically working drain was overlooked. An attempt was made to drain off the water by blowing off, and many engineers simply blow off the water when the water shows in the gauge; but sometimes you do not see the water in time. Sometimes a trap is used. In Fig. 1 is a method for draining, as can be seen by the arrangement of the pipes. A reliable steam trap is used, and the drain pipe is used entirely independent of the separator. The by-pass pipe is a branch introduced for conveying the flow through a partly opened valve. The arrangement can be quite easily comprehended by noticing the plan of the

connections. A device employing centrifugal force is shown in Fig. 2, in which the steam enters through the nozzle above and is deflected in its course down to the receiving chamber. This motion tends to throw off the entrained water as a sort of rotary motion is accomplished, the water running off to the bottom, while the steam passes upward through the outlet to the point of use.

Another form for separation by centrifugal force is shown in connection with the separator in Fig. 3. The steam is made to take a



spiral motion when it passes into the device, and a worm is provided for this purpose, located in the throat of the device. The pitch assumed in this worm gives the steam the required rotary motion as it passes downward and to the chamber. A continuous flow is made through the chamber. The heavier water particles are caused to fly tangentially from the axis of this moving body; and, as a result, the moisture adheres near the outer surfacing of the separator, whence it is drawn off through the drain pipe.

Sometimes the steam separator performs poor work because of choked passages In case the water is laden with foreign matter, previous to its entrance into the boiler for steam making, the chances are that the separator will get its share of the corrosive substance. I have found numerous effective steam separators out of commission, or performing poor service, due to the lack of attention in this respect. You might chop off pieces of adhering rusted substance from some of the vitals of separators. Then there is a lack of cleaning out of fine particles of loose matter, for I have seen pipes and valves partly stopped due to pieces of sand in the working parts. It is wisdom to keep the steam separator in good working order by cleaning out the mechanical parts regularly.

PUBLIC LIGHTING TABLES FOR DECEMBER, 1910.

[Communicated by The American Meter Company.]

Day of Week.	Table No. 1. FOLLOWING THE MOON. Date.	Light	Extinguish.	Day of Week.	Table No. 2. NEW YORK CITY. ALL NIGHT LIGHTING. Date.	Complete Lighting in 1 Hour.	Complete Extinguishing in 50 Minutes.
						From Time Given.	
		P.M.				P.M.	A.M.
Thu.	1	5.10 N.M.	6.00 A.M.	Thu.	1	4.07	5.52
Fri.	2	5.10	6.00	Fri.	2	4.07	5.52
Sat.	3	5.10	6.00	Sat.	3	4.02	5.57
Sun.	4	5 00	6.10	Sun.	4	4.02	5 57
Mon.	5	5.00	6.10	Mon.	5	4.02	5.57
Tue.	6	7.40	6.10	Tue.	6	4.02	5.57
Wed.	7	8.50	6.10	Wed.	7	4.02	5.57
Thu.	8	9.50	6.10	Thu.	8	4.02	5.57
Fri.	9	11.00 F.Q.	6.10	Fri.	9	4.02	5.57
		A.M.					
Sat.	10	12.10	6.10	Sat.	10	3.57	6.07
Sun.	11	1.20	6.10	Sun.	11	3.57	6.07
Mon.	12	2.40	6.10	Mon.	12	3.57	6.07
Tue.	13	4.00	6.10	Tue.	13	3.57	6.07
Wed.	14	No L.	No L.	Wed.	14	3.57	6.07
Thu.	15	No L. F.M.	No L.	Thu.	15	3.57	6.07
Fri.	16	No L.	No L.	Fri.	16	3.57	6.07
Sat.	17	5.10 P.M.	6.50 P.M.	Sat.	17	3.57	6.17
Sun.	18	5.10	8.00	Sun.	18	3.57	6.17
Mon.	19	5.10	9.10	Mon.	19	3.57	6.17
Tue.	20	5.10	10.30	Tue.	20	3.57	6.17
Wed.	21	5.10	11.30	Wed.	21	3.57	6.17
Thu.	22	5.10 L.Q.	12.40 A.M.	Thu.	22	3 57	6.17
Fri.	23	5.10	1.40	Fri.	23	3.57	6.17
Sat.	24	5.10	2.40	Sat.	24	4.02	6.22
Sun.	25	5.10	3.40	Sun.	25	4.02	6.22
Mon.	26	5.10	4.40	Mon.	26	4.07	6.22
Tue.	27	5.10	5.40	Tue	27	4.07	6.22
Wed.	28	5.10	6.20	Wed.	28	4.07	6.22
Thu.	29	5.10	6.20	Thu.	29	4.07	6.22
Fri.	30	5.10	6.20	Fri.	30	4.07	6.22
Sat.	31	5.10 N.M.	6.20	Sat.	31	4.12	6.27

Items of Interest
FROM VARIOUS LOCALITIES.

"Manager E. M. Stack is now congratulating owner Scranton (and in the interim has a good word to say for himself) over the satisfactory completion of the new storage holder that the Riter-Conley Company, of Pittsburgh, Pa., completed this month for the Scranton (Pa.) Gas and Water Company. The holder is of the telescopic order, in 3 lifts, averaging 33 feet each, and the diameter is 150 feet. It rests in a steel tank. The whole structure reflects great credit on its designers and constructors, and is good testimony to the efficiency of Mr. Willard B. Osborne as an estimator and erector, and to the skillfulness of its field force. All this is said for the efficiency and skillful end, for the site selected presented an engineering problem that was well out of the general order in such cases, and reckoning the time in which the work was done. We have not the exact date when the contract was awarded, but it was signed for some time in the fall and the work was completed the first week this month, and completed without a single hitch. Truly, President Carpenter's men seem to be animated with that zeal which of a verity characterizes their boss.—M. R. M."

Cows with crumpled horns; cows that have shown their enmity towards pails by kicking them over; bulls that have chased the summer boarder, have impaled rails and even the fence posts, have invaded crockery shops and the like, have been reported and put in print at divers times. Now it remains for a New Jersey bull to have put upon him the laurels that are the award of merit to those who seek new fields for explorations. As the story goes, some days ago a farm hand was leisurely leading a bull to his undoing in a Bristol (N. J.) abbatoir. While passing a lonely farmhouse the bull broke away from his custodian and made a dash for the habitation, which was the home of a Mr. Rud. Passing rapidly down the alleyway, instead of keeping on to the barn, the beast made a flying switch to the rear of the habitation, bolted into the kitchen and horned things generally. During the "horning" process he rammed a gas stove to its undoing the connection. He did not get his nostrils out of the way quick enough, or at least until he had inhaled a plenty of carburetted water gas that put him out in short order. The farm hands speedily roped him up, he was hauled into the open, and the work subsequently done on him did away with the necessity of going on to the abbatoir. All this is vouched for by the Milwaukee (Wis.) *Journal* of the 2d inst.

The Board of United States Steamboat Inspectors, in charge of the transportation on the Great Lakes of the Central West, have ruled as follows respecting the carrying of acetylene gas tanks aboard passenger steamers: "Acetylene may be transported on steamers carrying passengers only when contained in steel tanks of not less than 55,000 tensile strength to the square inch and charged with acetylene to make a pressure of not to exceed 240 pounds to the square inch. Said tanks are to be completely filled with asbestos disks, the porosity of which shall not exceed 60 per cent. A further condition is that tanks containing acetylene are to be stamped with the thickness and tensile strength of the material of which they are composed, also with the words, 'Acetylene compressed into porous substance,' together with the name of firm or company by whom the tanks have been charged."

The new gas rate instituted by the U. G. I. Company in its Conshohocken (Pa.) division is $1.25 per 1,000 cubic feet.

Mr. Chas. F. Leonard has engaged in the business of Consulting Engineer, with headquarters, No. 220 Broadway, New York. This gentleman, whose experience in the gas business covers a period of several years, particularly in the service of the Fall River (Mass.) Gas Works Company, needs no recommendation from us on the score either of straightforwardness or efficiency.

Towards the close of last month the City Council of Twin Falls, Idaho, granted Mr. Earle E. Miller, of Des Moines, Ia., a franchise under the direction of which grantee was to construct and operate a gas works. The City Engineer of Twin Falls (Mr. C. H. Mull) can furnish particulars.

"Here is more and 'startling evidence' in support of the theory that the 'grasping monopolies' are always trying to get the best of it, and especially does the theory go that the aforesaid 'grasping' are forever-and-a-day clutching the throat of labor. The evidence is in the shape of three paragraphs from a recent issue of the St. Paul

(Minn.) *Despatch*, the contents of the paragraphs being as follows: 'City Hall and Court House employees narrowly escaped going without their salaries for last month. Some time ago the City Council passed a resolution authorizing the payment of an account of $1,083 34 to the St. Paul Gas Light Company from the fund for maintaining the City Hall and Court House. When Comptroller W. H. Farnham audited the resolution for the payment of November salaries he found the fund $400 short. The employees could not get their November pay and their December salaries must, as usual, be paid in January. This did not look good to the Comptroller, with Christmas coming on. He communicated with Mr. Paul Doty, Manager of the Gas Company, as to whether the gas bill could wait until January. Mr. Doty consented and the Council at its last meeting, to pass upon the payrolls, cut the payment for the Gas Company to $541.57, thus leaving sufficient in the fund to give the janitors their salaries.'—B. S. B."

Mr. William S. Morse, of Fortville, Ind., has been appointed by State Geologist-elect, to succeed Mr. Bryce McKinney as Inspector of Natural Gas.

The franchise granted by the town authorities of Fairhaven, Mass., to the New Bedford Gas and Edison Light Company, under which the latter is to furnish gas to the former, has been duly signed by both parties to the pact. And this ends a long negotiation.

Another mark of esteem, was made on the resignation of Mr. Ralph S. Gavitt from the position of Superintendent of the Leominster (Mass.) Gas and Electric Light Company, when he was the guest of honor at a farewell dinner tendered him by some intimate friends. It was served in the Sterling Inn, and was attended by perhaps two-score guests, many of whom were of the weaker sex, under the chaperonage of Mrs. F. J. Woodbury.

A well attended meeting of the Gas Study Club, of Wilmington, Del., was held the evening of the 6th inst. The main topic of the evening was the paper by Mr. Edward Collier, who dealt very cleverly with the subject of "Service." The author dwelt mainly over the consideration of ways and means by which the customers of gas companies could secure prompt and efficient service at times when speed was a desideratum, and at times when finish was the main object in an installation. Commercial Manager Schutt, and Messrs. Frame, Wilgus and Harper, who had just returned from an examination of the appliance show in Boston, and an assistance at the proceedings of the annual meeting of the National Commercial Gas Association, took part in the discussion, and Mr. Schutt referred to the paper on the subject in hand tbat had been read during the Boston convention, by Mr. C. Willing Hare. Another man who gave good impetus to the discussion was Mr. D. C. Plank. The officers elected were: President, W. P. McCracken; Vice-President, W. F. Frame; Treasurer, R. W. Langford; Secretary, Frank Vernon; Trustees, J. H. Stickle, F. Kiefer, Thomas Fedigan; Council, M. E. Hooper, George Wilgus, James Crossman and M. J. Conway. The Club is in good condition, is being intelligently directed, and is sure to accomplish much good for the men and the Company.

The shareholders of the New Britain (Conn.) Gas Light Company, at a special meeting held early this month, to determine whether or not to increase the capital stock in the sum of $100,000, unanimously indorsed the proposition.

Mr. Paul Challiss, formerly in charge of the plant of the Greeley (Col.) Gas and Electric Company, informs us that, "After mature consideration, I have concluded to abandon the gas field, and a salaried position, and will engage in business on my own account. This determination, on many accounts, was taken not without regret; but circumstances make it seem best. * * * With many thanks for past favors, and with earnest wishes for your continued success, let me further say, always remember, if there is anything I can do for you at any time you have merely to let me know."

Mr. Challiss has joined the law firm of Waggener & Challiss, successors to Waggener, Orr & Challiss, whose headquarters are in the Hetherington Building, Atchison, Kas. May he always have the very best of good luck.

Mr. L. M. Banks, writing under date of the 9th inst., from Fort Collins, Col., says: "This city will be lighted by a combination of gas and electricity, the City Council having awarded contracts to the Northern Colorado Power Company and to the Poudre Valley Gas Company. The latter will install gas arcs on three of the blocks in the business section of the city, which blocks are from 300 to 600 feet long, the spacing of the lamps to be 150 feet apart. The electric end of the lighting calls for the placing of a certain number of tungsten lamps on 5 named blocks of the city—in residence and business divisions—the lamps being adjusted on the existing telephone and telegraph poles."

"Frank" L. Gross, writing to us from Denver, Col., under date of the 9th inst., says one of the daily newspapers there "Carried an account of a divorce suit recently brought in Trinidad, Col., by a Mrs. Mabel Carbould, wife of a veterinary surgeon of like name—save that the Doctor's begins with Thomas—which account I thought might fit in somewhere in the chapters on the excellent compilation, by Mr. J. E. Brady, respecting gas cases arising from various accounts of the misuse of gas, which compilation has been profitably occupying pages in the Journal for some time back. One of the main allegations in the complaint of Mrs. Carbould was that on one occasion, while she and her child were asleep in their home, Carbould, with the intention of injuring them bodily, disconnected a bracket fixture from the riser-pipe. The decision favored complainant's petition, and the divorce decree was entered. But, in your correspondent's belief, the end should not be with the filing of the divorce decree; but that defendant should be proceeded against on criminal account, for one can hardly imagine a more dastardly crime than that which the evidence submitted would smirch him with attempting."

Harold T. Sloper, Manager of the New Britain (Conn.) Gas Light Company, bas placed an order with the Corbin Motor Vehicle Company for a special automobile truck for delivery purposes. Having inspected in the general market the types of these vehicles available for gas works' use, Mr. Sloper suggested to the Motor Company a plan for one coming between the heavy and light types of truck on the market, with the result that the constructors will manufacture one according to the designs of Manager Sloper.

The Ardmore Electric and Gas Company has been iacorporated by Messrs. C. C. Helsen, E. M. Hammond, G. A. Jewett and C. C. Hamilton, with a nominal capitalization of $10,000. It is likely that this combination proposes to construct a gas plant in Ardmore, S. D.

Mr. E J. Garland, of Pekin, Ills., who has been in the service of the industrial division of the Peoria (Ills.) Gas Company, resigned that position early this month to accept a more remunerative one with the Federal Electric Light Company, of Detroit. He is a capable, energetic and persevering man, and he has many on his list of acquaintances who wish him pronounced success in his new field of work.

We understand that certain capitalists of Vinton, Ia., are arranging the terms for a franchise under which they will construct and operate a gas works in Twin Falls, Ia.

It is reported that the proprietors of the Citizens Heat and Light Company, who formerly operated the supplying of natural gas to Elwood, Ind., have arranged for the construction of an artificial gas plant for that place. It is understood that the erection of the works will be undertaken, with the general idea that the supply of gas will be practically commenced by May 1st.

Mr. T. J. Brewster is informed that the new rate (85 cents per 1,000, net) announced by the Washington (D. C.) Gas Company becomes effective the 1st prox.

The American Construction Company have been awarded the contract for the erection of the gas plant at Belle Plaine, Ia.

Mrs. Helen Armstrong has just completed one of her excellent demonstration courses on gas for cooking, the course having been conducted at the Chronicle Cooking School, Augusta, Ga. The lectures were largely attended.

The Board of Trade, Commerce, Tex., has applied to the Chamber of Commerce, Dallas, Tex., the burden of the plaint being the desire to be put in communication with builders of gas plants, with a view to putting in such an installation in Commerce.

The Fitchburg (Mass.) *Sentinel*, of recent date had this to say respecting the lighting of the recent gas appliance show in Boston: "It is a revelation to see the illumination at Mechanics' Building at the Gas Show, now being held in Boston. The entire sidewalk in front of the building is lined with artistic white posts, each bearing two of the inverted outside gas arcs which have proved so efficient. At the entrances are posts bearing four of these arcs, and over the main entrance is a double arch of lamps. The result is a blaze of light along the entire front of the building, and yet a light which, though powerful, is soft and particularly attractive. The inside effect is little short of marvelous. Special large chandeliers presenting an artistic shower effect are equipped with inverted gas arcs, and the result is a flood of soft, pure white light, literally making the hall as bright as day. Around the top of the hall is a continuous row of single burner lamps close together, yielding a highly decorative effect. The big arch over the stage is studded with gas arc lamps, inclosed in the form of crystal chandeliers, giving a peculiarly artistic effect to that end of the hall. In the individual exhibits are shown a great number of different varieties of lamps and lighting equipment suitable for every possible lighting requirement, from the biggest office to the smallest residence, and from show window lighting to the lighting of streets, store fronts, and large outside areas."

Mr. James Eagan, Superintendent of Works, Detroit (Mich.) City Gas Company, died at his home in Detroit, the morning of the 4th inst. He was in his 73d year, and had been connected with the Company for over 40 years.

The Empire District Electric Company has purchased control in the gas plants at Carthage and Webb City, Mo. Mr. O. J. McLain represented the purchasers in the preliminary negotiations.

THE AMERICAN GAS LIGHT JOURNAL

A. M. CALLENDER & CO.,
PROPRIETORS.

THOS. J. CUNNINGHAM,
ELBERT P. CALLENDER,
EDITORS.

CHARLES H. WADELTON,
MANAGER.

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MONDAY, DECEMBER 19, 1910.

DIVIDEND NOTICE.

OFFICE OF THE UNITED GAS IMPROVEMENT CO.,
N. W. CORNER BROAD AND ARCH STS.,
PHILADELPHIA, December 14, 1910.

The Directors have this day declared a quarterly dividend of 2 per cent. (one dollar per share), payable Jan. 14th, 1911, to stockholders of record at the close of business, Dec. 31, 1910. Checks will be mailed.

1854-4 LEWIS LILLIE, Treasurer.

The Market for Gas Securities.

The current quotations for Consolidated are virtually those of last week—132¾ to 133. The market seems quite bare of stock, and there is still an outstanding line of shorts, a goodly part of which it is natural to suppose will be closed out prior to the first of the year. So it is reasonable to look for quite an advance in values between now and January 1st.

Brooklyn Union, despite the fact that no increase in the dividend rate was made, advanced 2 points. Well informed men, as to the probable course of this sterling security, are not at all backward in declaring that the shares will be on an 8 per cent. basis before the end of 1911. The general gas share market is in healthy condition. The regular quarterly dividend of the U. G. I. Company (2 per cent., or $1 per share) is payable the 14th prox.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

115 BROADWAY, NEW YORK CITY.

DECEMBER 19.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share:

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked*
Consolidated Gas Co.	$73,177,000	100	132¾	133
Central Union Gas Co. — 1st 5's, due 1972, J. & J.	8,000,000	1,000	98	101
Equitable Gas Light Co.— Con. 5's, due 1932, M. & S.	1,000,000	1,000	—	105
Mutual Gas Co.	3,500,000	100	155	165
New Amsterdam Gas Co.— 1st Con. 5's, due 1948, J. & J.	11,000,000	1,000	100	101½
New York & Richmond Gas Co. (Staten Island)	1,500,000	100	35	50
1st Mtg. Gold Bds. 5 p. ct.	1,000,000	—	98½	100½
New York and East River— 1st 5's, due 1944, J. & J.	3,500,000	1,000	104	107
Con. 5's, due 1945, J. & J.	,500,000	—	97	101
Northern Union— 1st 5's, due 1927, J. & J.	1,250,000	1,000	94	100
Standard	5,000,000	100	—	75
Preferred	5,000,000	100	70	100
1st Mtg. 5's, due 1930, M. & N.	1,500,000	1,000	100	105
The Brooklyn Union	15,000,000	1,000	132½	135
1st Con. 5's, due 1948, M. & N.	15,000,000	—	106½	107
Yonkers	299,650	500	130	—
Out-of-Town Companies.				
Bay State	50,000,000	50	⅝	¾
" Income Bonds	2,000,000	1,000	—	75
Binghampton Gas Works	450,000	100	—	65
" 1st Mtg. 5's	500,000	1,000	90	96
Boston United Gas Co.— 1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	5	8
Bonds, 5's	5,250,000	1,000	73	73½
Capital, Sacramento	500,000	50	—	35
Bonds (6's)	150,000	1,000	—	—
Chicago Gas Co. Guaranteed Gold Bonds	7,660,000	1,000	104	106¼
Cincinnati Gas and Electric Co.	29,500,000	100	92	93
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,500,000	1,000	96	98
Columbus (O.) Gas Lt. & Heating Co.	1,682,750	100	90½	91
Preferred	3,026,500	100	75½	80
Consumers, Toronto	2,000,000	50	200	204
Consolidated, Baltimore	11,000,000	100	106½	—
Mortgages, 6's	3,600,000	—	89	100
Chesapeake, 1st 6's	1,000,000	—	—	—
Equitable, 1st 6's	910,000	—	—	—
Consolidated, 1st 5's	1,490,000	—	—	112
Consolidated Gas Co. of N. J.	1,000,000	100	15	17
Con. Mtg. 5's	880,000	1,000	92	95
Bonds	75,000	—	—	100
Denver Gas and Electric	3,500,000	—	102	105
Detroit City Gas Co	5,000,000	50	—	50
" Prior Lien 5's	4,619,000	1,000	97	100½
Detroit Gas Co., 5's	881,000	1,000	75	80
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	—	101
Essex and Hudson Gas Co.	6,500,000	—	39	40
Fort Wayne	2,000,000	—	—	—
" Bonds	2,000,000	—	55	—
Grand Rapids Gas Light Co., 1st Mtg. 5's	1,225,000	1,000	104½	105
Hartford	750,000	25	190	200
Hudson County Gas Co., of New Jersey	10,500,000	—	112	113½
" Bonds, 5's	10,500,000	—	108	108½
Indianapolis	2,000,000	—	60	70
" Bonds, 5's	2,650,000	—	104½	105
Jackson Gas Co.	250,000	50	82	—
" 1st Mtg. 5's	290,000	1,000	97	100
Kansas City Gas Light Co., of Missouri	5,000,000	100	—	36
Bonds, 1st 5's	3,822,000	1,000	102	104
Laclede Gas Co., St. Louis	10,000,000	100	104¾	105
Preferred	2,500,006	100	91¾	102
Bonds	10,000,000	1,000	102½	103
Lafayette Gas Co., Ind.	1,000,000	100	—	60
Bonds	1,000,000	1,000	60	65
Louisville	2,570,000	50	143	145
Madison Gas and Electric Co. " 1st Mtg. 6's	350,000	1,000	106	106¾
" 6 per cent. scrip, due 1910	100,000	25	60	60¼
Massachusetts Gas Companies, of Boston	35,000,000	100	88½	88¾
Preferred	25,000,000	100	94¼	94⅜
Montreal Gas Co., Canada	2,000,000	100	218	218¾
Nashville Gas Light Co.	1,000,000	100	110	—
Newark, N. J., Con. Gas Co.	6,000,000	—	56	58
Bonds, 6's	6,000,000	—	137	138
New Haven Gas Co.	2,000,000	25	200	—
Peoples Gas Lt. & Coke Co., Chicago	25,000,000	100	105	105⅛
1st Mortgage	20,100,000	1,000	—	—
2d "	2,500,000	1,000	104	—
Rochester Gas & Electric Co.	2,150,000	50	88	—
Preferred	2,150,000	50	118	—
Consolidated 5's	2,000,000	—	104½	105½
San Francisco Gas Co., Cal.	15,500,000	—	—	—
St. Joseph Gas Co.— 1st Mtg. 5's	751,000	1,000	100	102
St. Paul Gas Light Co.	1,500,000	100	45	47
1st Mortgages, 6's	650,000	1,000	113	116
Extension, 6's	600,000	1,000	112½	115
General Mortgage, 5's	2,465,000	1,000	90	95
Syracuse Gas Co., N. Y.	1,975,000	100	50	55
Bonds	2,047,000	1,000	100	104
Washington (D. C.) Gas Co.	1,600,000	200	367	370
1st Mortgage, 6's	600,000	—	—	—
Western Gas Co., Milwaukee	4,800,000	—	—	—
Wilmington (Del.) Gas Co.	600,000	50	361	—

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WILLIAM A. BAEHR,
CONSULTING ENGINEER,

PEOPLES GAS BUILDING, CHICAGO.

Also Representing The Bartlett Hayward Company.

BIDS FOR REGULATORS.

Sealed bids or estimates for furnishing, putting in place and maintaining 219 gas regulators in the public buildings, Borough of Brooklyn, City of New York. These are to be operated for the year, beginning January 1, 1911, and terminating December 31, 1911. For further particulars, blank forms, etc., apply to Department of Water Supply, Gas and Electricity, Room 2,339 Park Row Building, New York.

1854-1 H. S. THOMPSON, Commissioner.

Position Wanted.

An experienced gas manager, now employed as manager, desires a similar position either with a natural or artificial gas company, in a city of 20,000 population or over. No preference as to location of city. Can leave present position on 30 days' notice. Results guaranteed.

Address, "A.,"

1843-tf Care this Journal.

WANTED,

Position as Manager and Superintendent of Gas Plant.

Best of references given. Fifteen years' experience in gas business. Address, "F.,"

1846-tf Care this Journal.

POSITION WANTED.

A gas manager, now employed, desires similar position in city of 15,000 population or over. Excellent record for results obtained in all departments and will refer to past and present employers. Address, "D. S. C.,"

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Position Wanted

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On Friday, January 20, 1911, at 2 o'clock P.M., the property of the McCook Gas Company will be sold at public auction to the highest bidder for cash, purchaser to assume bond indebtedness of $10,000. Plant is paying operating expenses, but present owners unable to give it personal attention. For particulars, address

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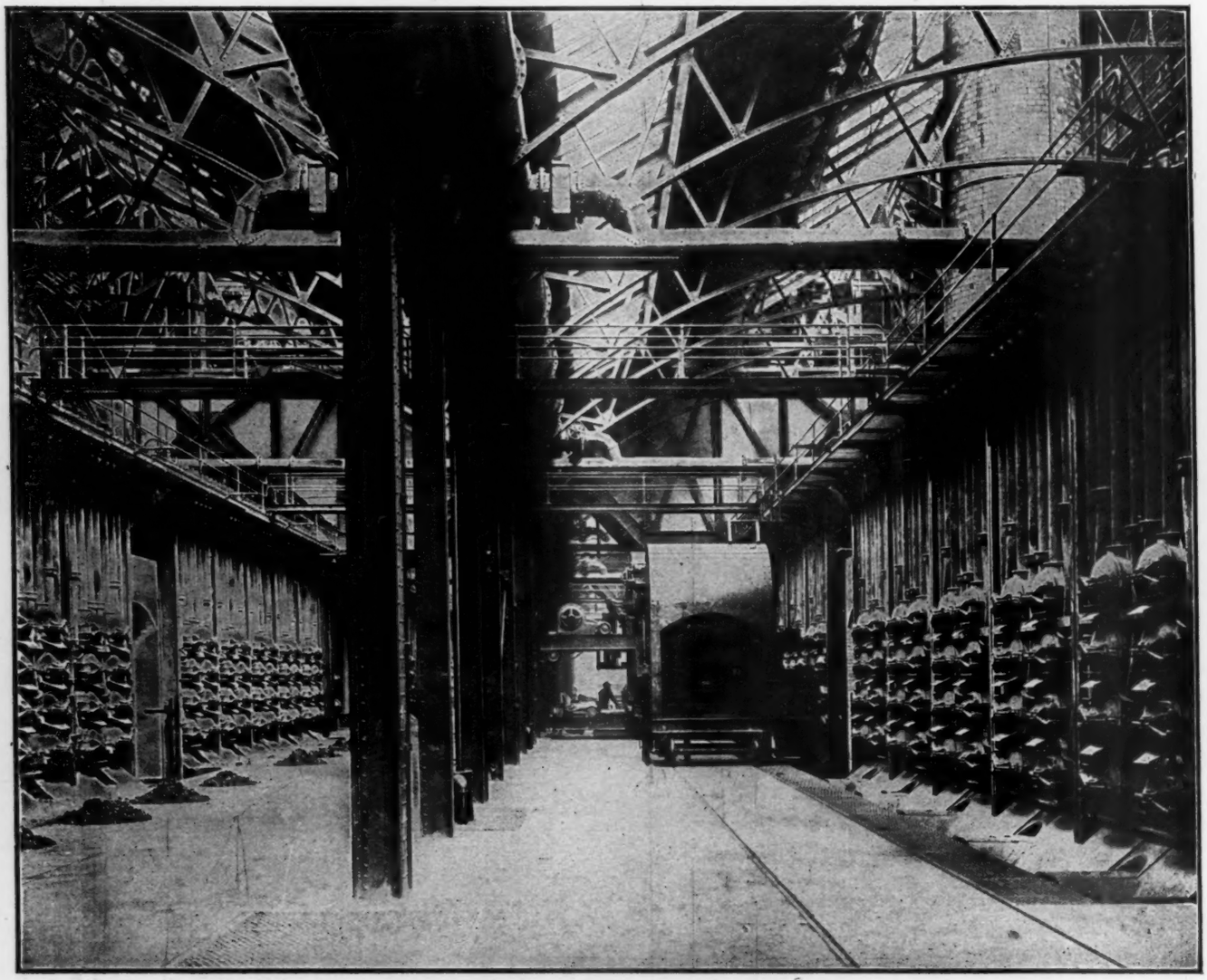

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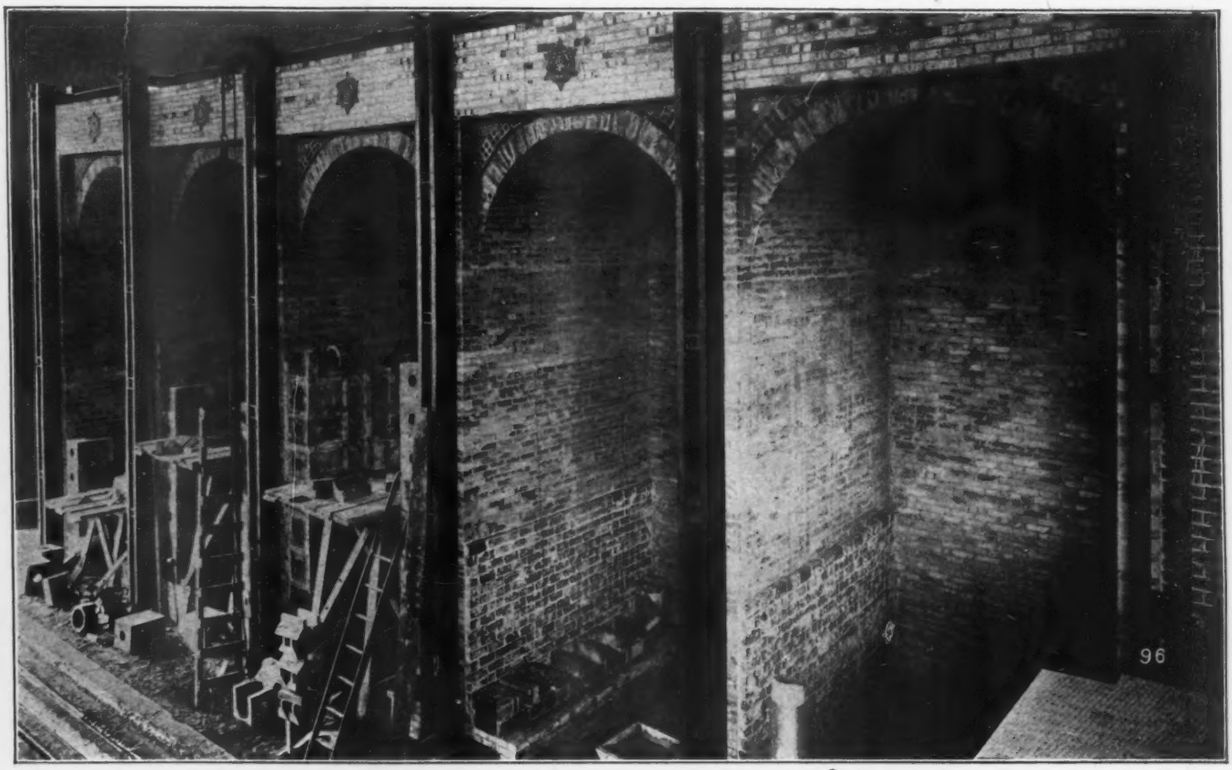

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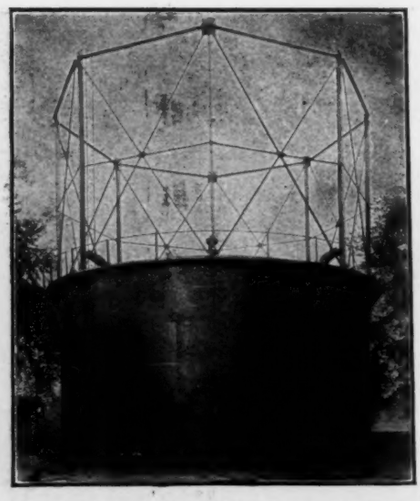

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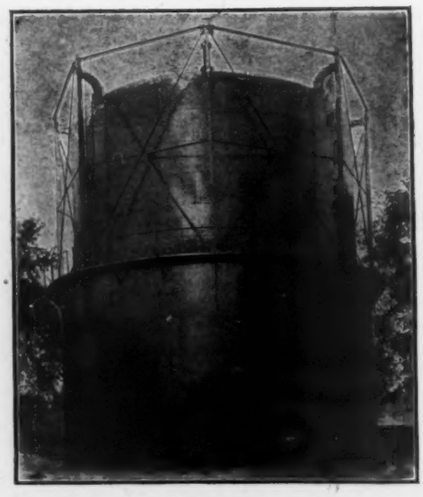

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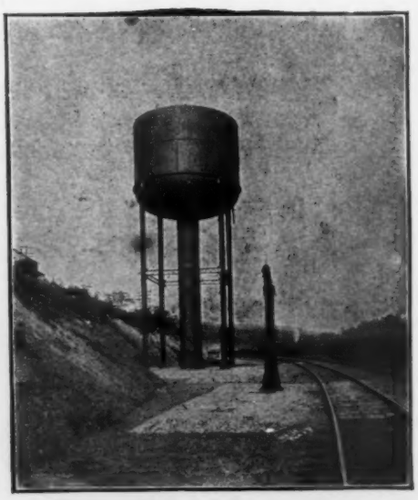

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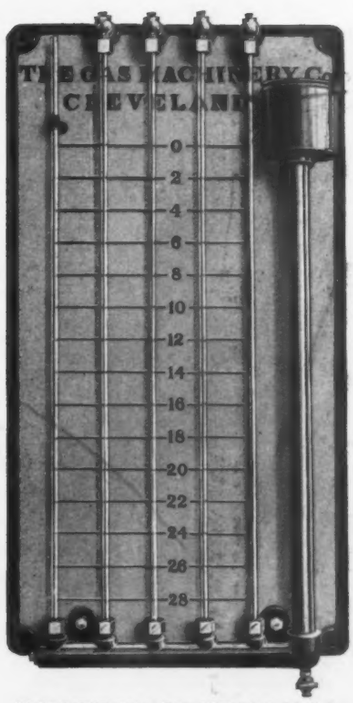

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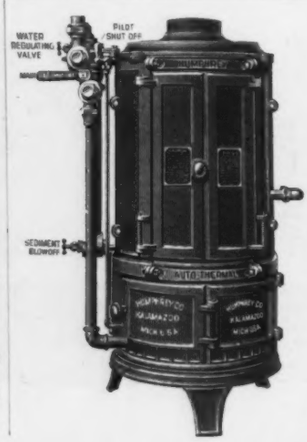

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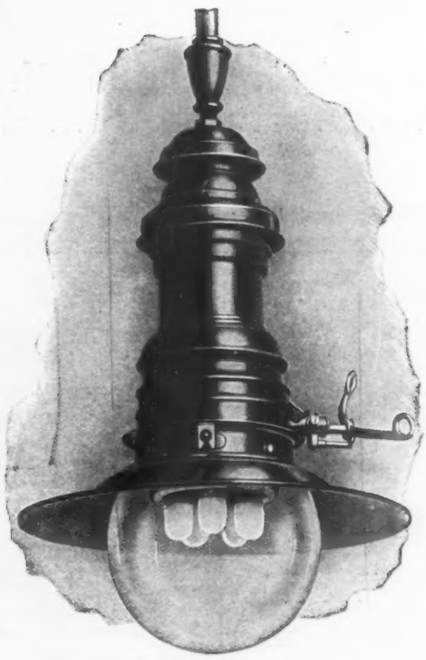

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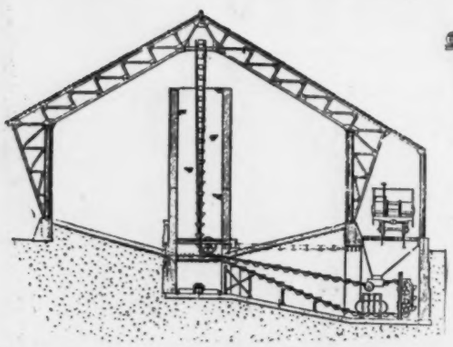

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American Gas Institute.—Annual meeting, October, 1911. ————————. Officers: President, Donald McDonald, Louisville, Ky. Secretary, A. B. Beadle, 29 West 39th st., N. Y. City.

Canadian Gas Association.—Annual meeting, June, 1911. ————————. Officers President, Arthur Hewitt, Toronto, Ont.; Secretary and Treasurer, John Keillor, Hamilton, Ont.

Empire State Gas and Electric Association.—Annual meeting, Nov., 1910. New York City. Officers: President, C. R. Huntley, Buffalo, N. Y.; Secretary, C. H. B. Chapin, 29 W. 39th street, New York City.

Guild of Gas Managers of New England.—Annual meeting, December. Young's Hotel, Boston; monthly meeting, second Saturday. Officers: President, A. K. Quinn; Newport, R. I.; Secretary, Walter G. Africa, Manchester, N. H.

Illinois Gas Association.—Annual meeting, time, March, Chicago, Ills. Officers: President, A. S. Harrington, Chicago, Ill.; Secretary-Treasurer, C. B. Strohn, Elgin, Ill.

Illuminating Engineering Society.—Annual meeting, Oct., —, 1911. Meetings of Sections, monthly. President, E. P. Hyde, Cleveland, O.; Secretary, Preston S. Millar, 29 W. 39th street, N. Y. City. Sections: New York: Secretary, Albert J. Marshall, 36 West 39th street. New England, Secretary, L. D. Gibbs 39 Boylston street, Boston, Mass. Philadelphia, Secretary, F. N. Morton, Broad and Arch streets Chicago, Secretary, F. H. Bernhard, Marquette Building.

Indiana Gas Association.—Annual meeting, Jan. 18 and 19, 1911, Fort Wayne, Ind. Officers: President, Carl H. Graf, Indianapolis; Vice-President, S. E. Mulholland; Secretary-Treasurer, Philmer Eves, Indianapolis Gas Company, Indianapolis, Ind.

Iowa District Gas Association.—Annual meeting, time, June, 1911, ————————. Officers: President, Austin Burt, Waterloo, Ia.; Secretary and Treasurer, G. I. Vincent, Des Moines, Ia.

Kansas Gas, Water and Electric Light Association.—Annual meeting, time, ———— Wichita, Kas. Officers: President, W. A. Scothorn, Hutchinson, Kas.; Secretary and Treasurer, J. D. Nicholson, Newton, Kas.

Michigan Gas Association—Annual meeting, time, Sept. 1911; Detroit, Mich. Officers: President, A. P. Ewing, Detroit, Mich.; Secretary-Treasurer, Glenn R. Chamberlain, Grand Rapids, Mich.

Missouri Electric Light, Gas, Water Works and Street Railway Association.—Annual meeting, April 13, 14 and 15, 1911; St. Louis, Mo. Officers: President, R. J. Irvine; Secretary and Treasurer, W. J. Cunningham, Springfield, Mo.

National Commercial Gas Association.—Annual meeting, December 5-12, 1911. Denver, Officers: President, C. N. Stannard, Denver; Secretary, Louis Stotz, 29 West 39th street, New York City.

Natural Gas Association.—Annual meeting, May 16, 17 and 18, 1911; Pittsburgh, Pa. Officers: President, John M. Garard, Columbus, O. Secretary, T. C. Jones, Delaware, O. Editor Wrinkle Department, F. W. Stone, Ashtabula, O.

New England Gas Association.—Annual meeting, third Wednesday in February, 1911; Boston. Officers: President, W. H. Snow, Holyoke, Mass.; Secretary-Treasurer, N. W. Gifford, East Boston, Mass.

Oklahoma Public Utilities Association.—Annual meeting, May 9, 10 and 11, 1911. Officers: President, E. C. Reynolds; Secretary, Galen Crow, Guthrie, Okla.

Pacific Coast Gas Association.—Annual meeting, Sept. 20, 21 and 22, 1911, Oakland, Cal. Officers: President, F. A. Leach, Jr., Oakland, Cal.; Vice-President, W. Baurhyte, Los Angeles, Cal.; Secretary-Treasurer, John A. Britton, 925 Franklin street, San Francisco, Cal.

Pennsylvania Gas Association.—Annual meeting, April, 1911, Reading, Pa. Officers: President, J. H. Keppelman, Reading, Pa.; Secretary-Treasurer, William H. Merritt, Lebanon, Pa.

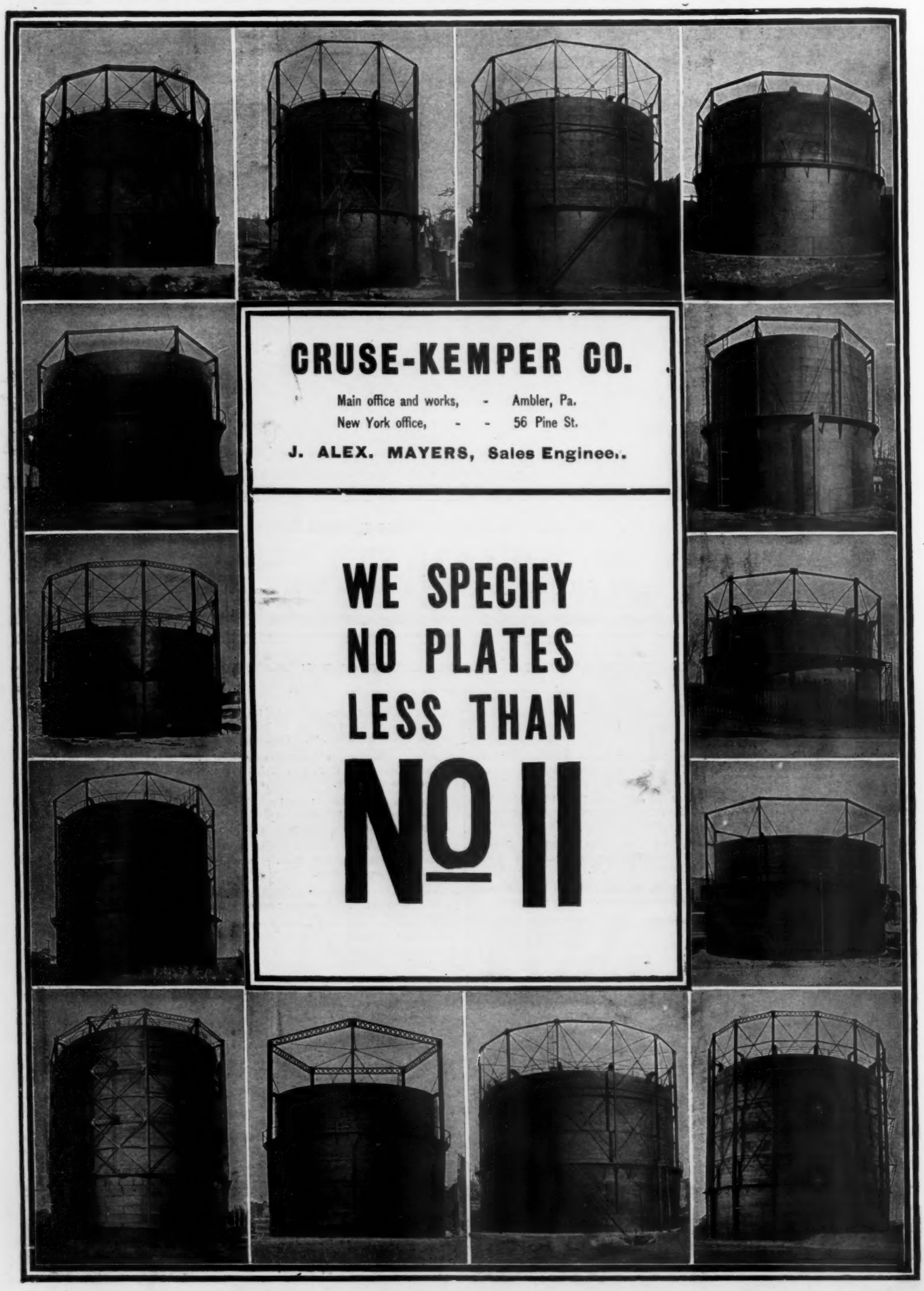
Society of Gas Lighting.—Annual meeting, December, 1911; monthly meeting, second Thursday. Place, New York City. Officers: President, Fred. S. Benson; Secretary, George G. Ramsdell, Waterbury, Conn.

Southern Gas Association.—Annual meeting, April 19-21, 1911, Montgomery, Ala. Officers: President, H. W. Frund, Salisbury, N. C.; Secretary-Treasurer, Jas. Ferrier, Rome, Ga.

Southwestern Electrical and Gas Association.—Annual meeting, May, 1911, ———— Tex. Officers: President, W. B. Tuttle, San Antonio, Tex.; Secretary, H. B. Head, Stephensville, Tex.

Wisconsin Gas Association.—Annual meeting, May ————, 1911, Milwaukee, Wis. Officers: President, W. H. Winslow, Superior, Wis.; Secretary-Treasurer, Henry Harmon, Milwaukee, Wis.

Directory of American Gas Companies, 1910. Price, $5.00. For Sale by American Gas Light Journal, 42 Pine St. N. Y. City.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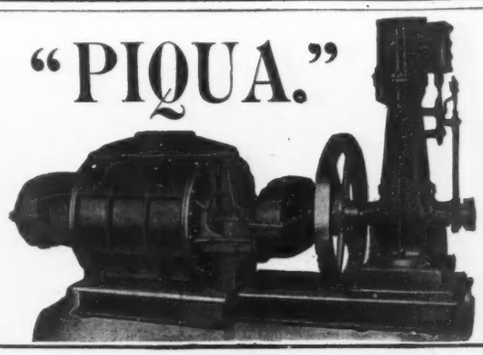

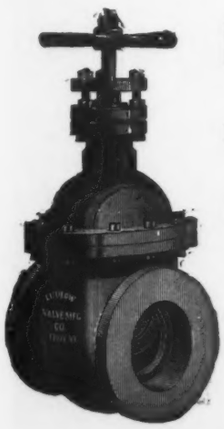

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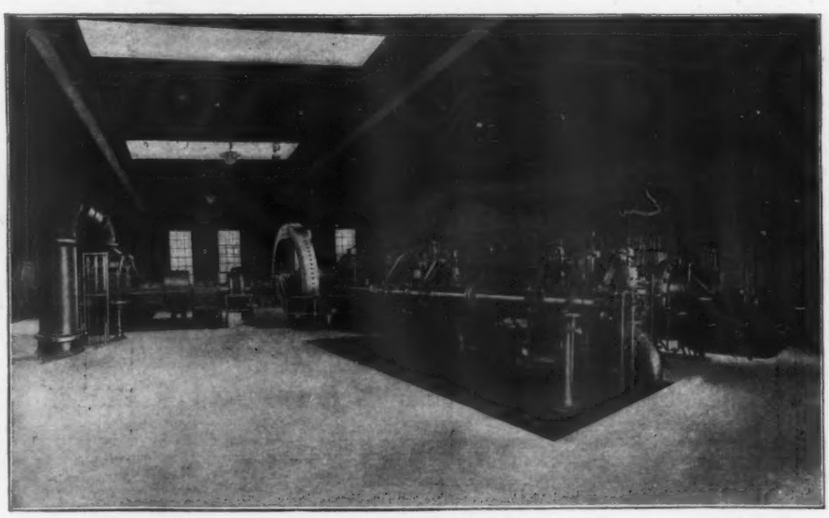

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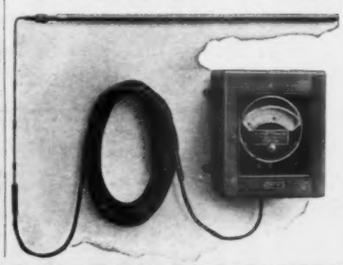

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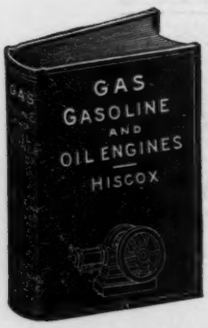

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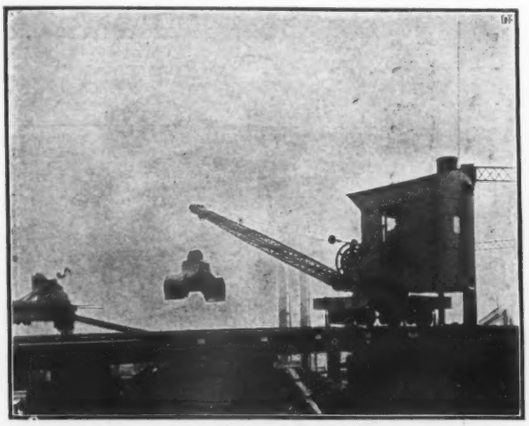

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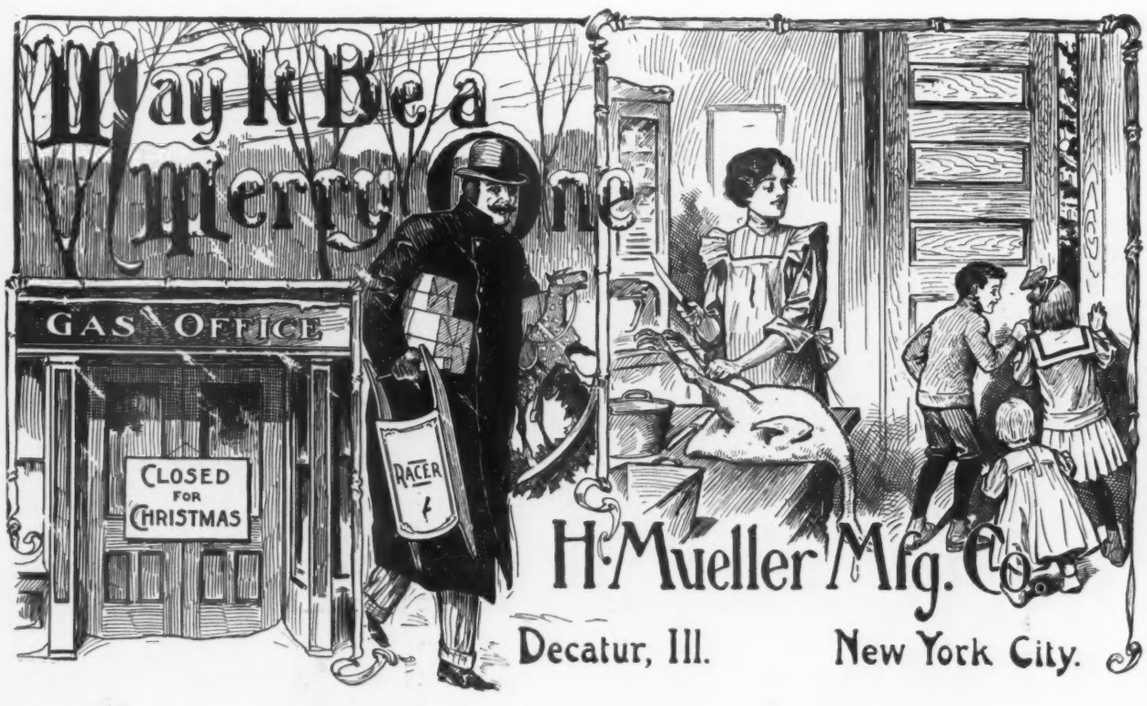

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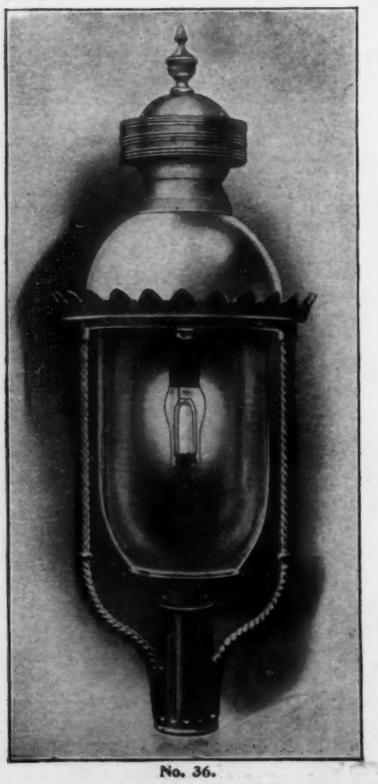

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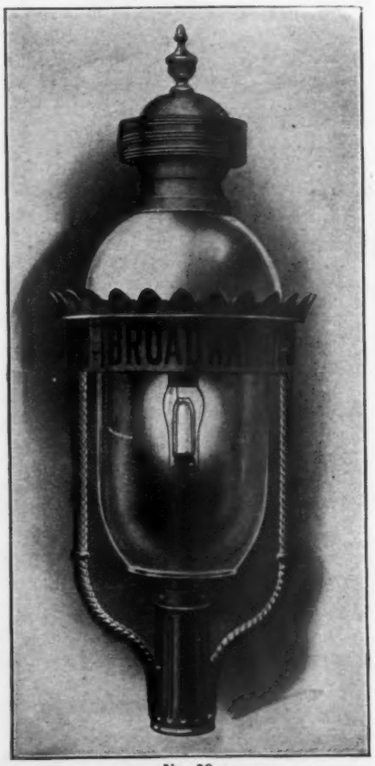

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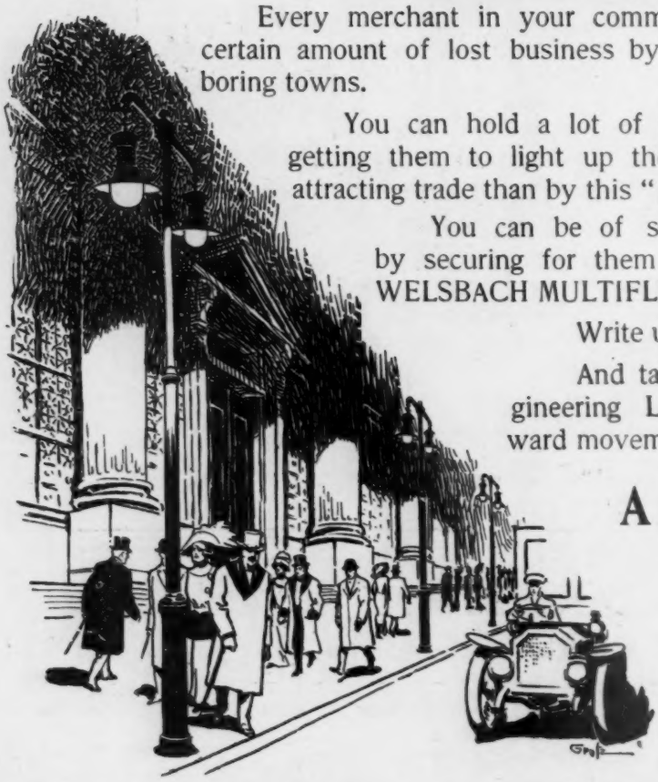

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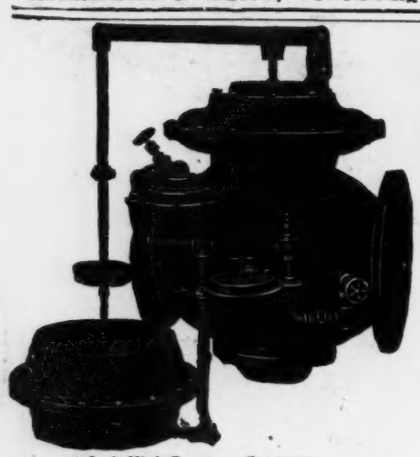

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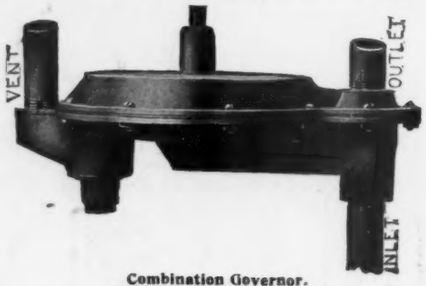

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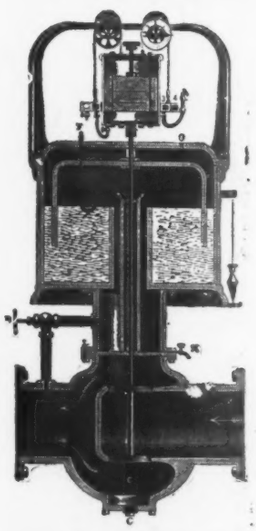

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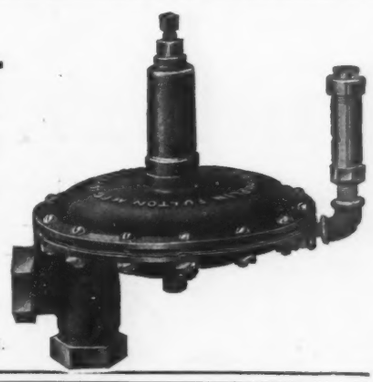

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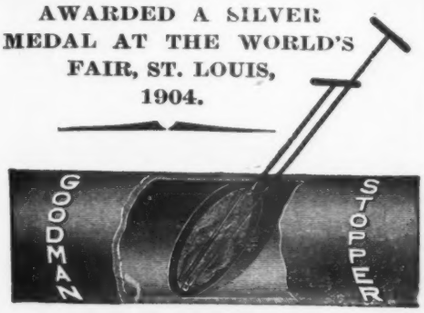

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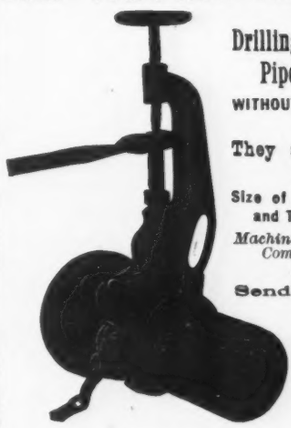

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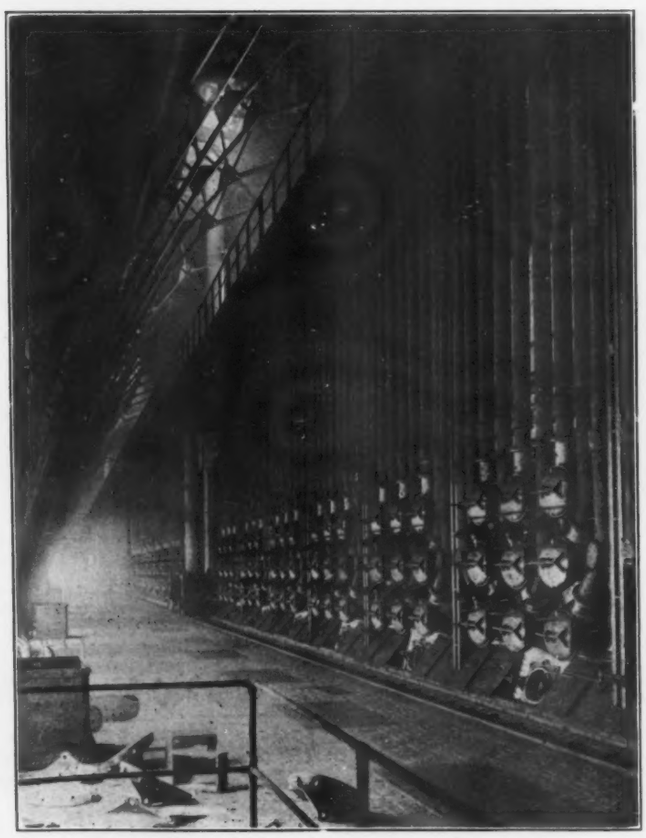

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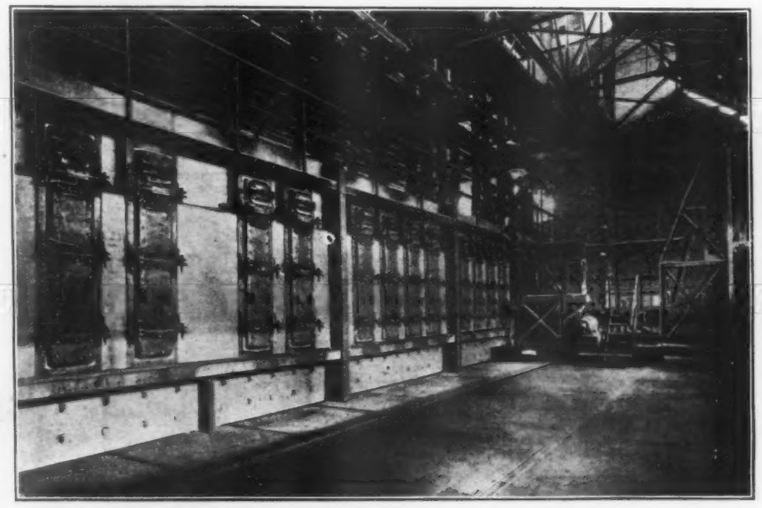

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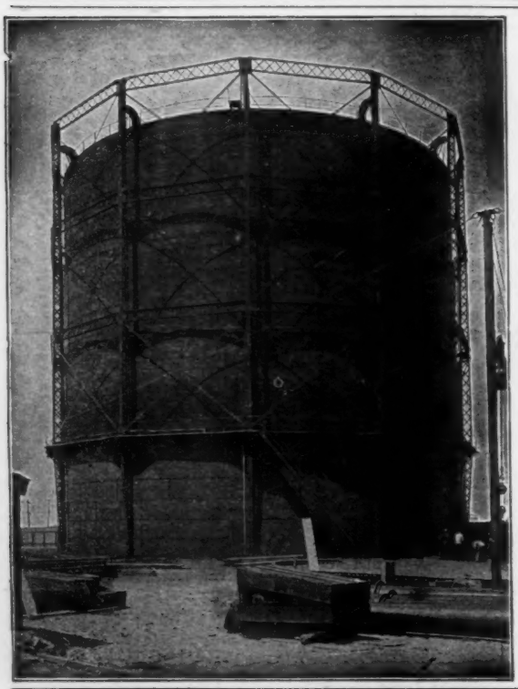

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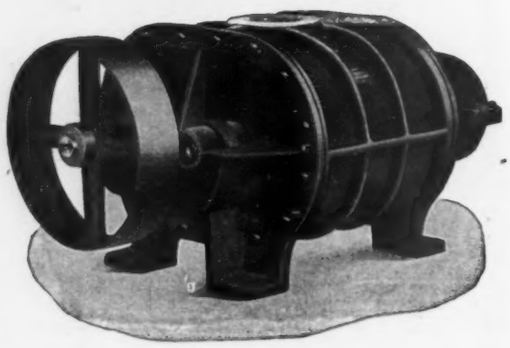

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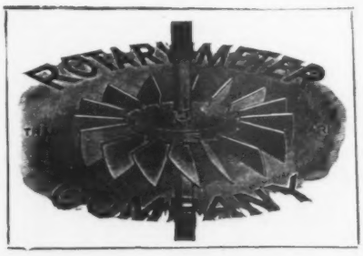

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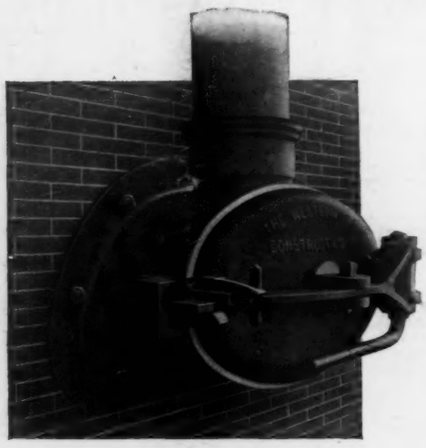

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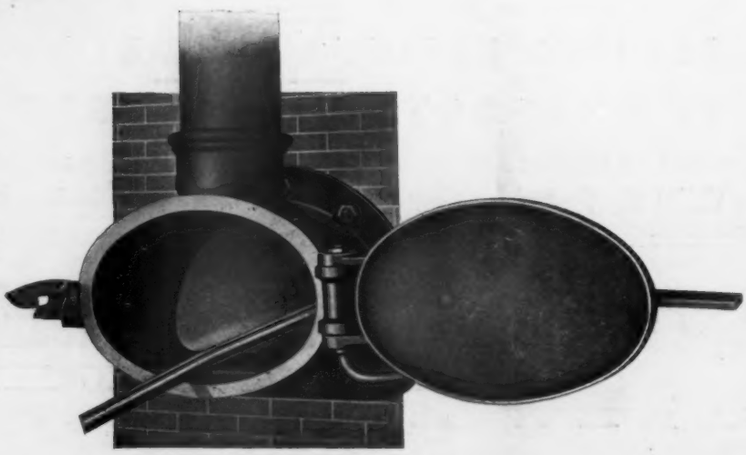

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